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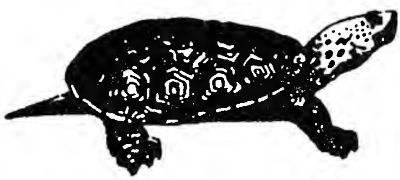
THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.



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Diets of two species of horned lizards (*Phrynosoma modestum* and *P. solare*) from Mexico

Most previous observations on the diets of lizards in the genus *Phrynosoma* have indicated that ants comprise the majority of prey items eaten (Pianka and Parker, 1975; Lemos-Espinal et al., 2004), although there is apparent plasticity in diets among populations of some species of *Phrynosoma* (e.g., *P. coronatum*, Suarez et al., 2000) and some species that include more non-ant insects in their diet (e.g., *P. taurus*, Lemos-Espinal et al., 2004). Such variability appears limited given present observations, but there remain some species of *Phrynosoma* for which diet observations are lacking, particularly species and populations from Mexico. One such species is *P. solare*, and we report on the diet of individuals from Sonora. In addition, expanding the number of populations of various species would allow a better understanding of the potential for interpopulation diet variation. To that end, we also report on the diets of *P. modestum* from Coahuila.

We examined specimens of *P. solare* (n = 14; 5 males, 9 females) and *P. modestum* (n = 11; 5 males, 6 females) from the collection of the Laboratoria de Ecología, UBIPRO-FES-Iztacala, UNAM (see Smith et al., 2005a,b for details of collection). *Phrynosoma solare* were collected from several localities in Sonora during the summer and fall of 2004 and the summer of 2005 (see Appendix). *Phrynosoma modestum* were collected from several localities in Coahuila during the summer and fall of 2004 (see Appendix). Specimens were preserved in formalin within 30 minutes of collection; thus, the effect of digestion on stomach contents was assumed to be minimal.

We dissected specimens to examine stomach contents. Diet items were identified to the lowest taxonomic level possible and counted. We measured the length and width of each prey item using a digital caliper (to nearest 0.01 mm) and calculated prey volume using the volume of a prolate spheroid. We used BugRun software to calculate niche breadth based on prey number and prey volume (Vitt and Zani, 2005). Sample sizes were low (11 or 14 stomachs) for both species. However, a rarefaction analysis conducted by Winemiller et al. (2001) suggested that samples of $\geq$ 10 include > 90% of a species' total diet.

The diet of *P. modestum* consisted primarily of ants, both numerically and volumetrically (Table 1). The only non-ant diet items we found were Coleopteran adults and larvae. Niche breadth based on number was 1.63, and based on volume was 2.78. Previous studies on the diets of *P. modestum* also found that ants predominate (e.g., Barbault et al. 1978; Shaffer and Whitford 1981), although this can vary seasonally (Barbault and Maury 1981).

The diet of *P. solare* was dominated by ants, both volumetrically and numerically (Table 2). Coleopteran adults and isopterans were present but relatively uncommon in the diet. We found a single unidentified seed in one stomach, which was likely accidentally ingested. Based on the number of prey items, niche breadth was 3.19, and on prey volume 1.73.

As expected, the diets of *P. solare* and *P. modestum* were dominated by ants, but did include other prey, especially beetles. These observations are consistent with those found by Pianka and Parker (1975) and Lemos-Espinal et al. (2004). We should note that *P. solare* is not an obligate ant specialist, since captive individuals fed a diet lacking ants were able to survive and grow (Sherbrooke, 1987).

Acknowledgments.

This study was supported by the Denison University Research Foundation and the Anderson Endowment of Denison University. We thank the late H.M. Smith for facilitating the loan of the specimens.

Table 1. Diet of *Phrynosoma modestum* from Coahuila, Mexico (n = 11).

Prey Taxon	Number of Stomachs	Number of Items	Percent of Diet by Number	Percent of Diet by Volume
Coleoptera				
Adult	5	13	7.74	20.02
Larvae	2	2	1.19	2.28
Hymenoptera Formicidae				
Morphospecies A	4	21	12.5	29.3
Morphospecies B	3	129	76.79	48.4
Morphospecies C	2	3	1.79	0.05

Table 2. Diet of Phrynosoma solare from Sonora, Mexico (n = 14).

Prey Taxon	Number of Stomachs	Number of Items	Percent of Diet by Number	Percent of Diet by Volume
Coleoptera Adult	4	4	3.23	6.47
Hymenoptera Formicidae				
Morphospecies A	4	60	48.4	74.9
Morphospecies B	2	16	12.9	6.55
Morphospecies C	2	9	7.26	0.17
Morphospecies D	1	29	23.39	0.54
Morphospecies E	1	4	3.23	0.07
Isoptera	1	1	0.81	3.09
Unidentified seed	1	1	0.81	8.17

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Julio A. Lemos-Espinal[1]
Laboratorio de Ecología (UBIPRO), Facultad de Estudios Superiores Iztacala, Av. de los Barrios s/n, Los Reyes Iztacala, Tlalnepantla, Edo. de México, MÉXICO 54090

Christopher J. Dibble[2]
Department of Biology, Denison University, Granville, OH 43023 USA

Geoffrey R. Smith
Department of Biology, Denison University, Granville, OH 43023 USA

[1]*Correspondence Author (lemos@unam.mex)*
[2]*Present Address: Department of Biology, Rice University, Houston, Texas 77251*

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Notes on Reproduction of the Texas Horned Lizard, *Phrynosoma cornutum* (Squamata: Phrynosomatidae), from New Mexico

Stephen R. Goldberg

Abstract.

Information on the reproductive cycle of *Phrynosoma cornutum* from New Mexico, USA was presented from a histological examination of museum specimens. Spermiogenesis (sperm formation) was underway in April. The smallest reproductively active male measured 64 mm SVL. This is a new minimum size for male *P. cornutum* reproductive activity. Females were reproductively active from April through July. The smallest reproductively active female (follicles > 5 mm) measured 98 mm SVL. Mean clutch size (N = 3) was 18.3 ± 4.5 SD, range = 14-23. There was no evidence *P. cornutum* from New Mexico produces multiple clutches in the same year. Like other species of North American *Phrynosoma*, *P. cornutum* is a spring breeder. This strategy allows neonates to hatch in summer with several months to feed and acquire fat before entering hibernation.

The Texas horned lizard, *Phrynosoma cornutum* (Harlan, 1825) ranges from Kansas to eastern Texas to south east Arizona and south to Durango, San Luis Potosí and Tamualipas, Mexico (Stebbins, 2003). It lives in a variety of habitats including arid and semi-desert grasslands, chaparral, and thorn scrub (Hodges, 2009). The most detailed information on its reproduction is in Ballinger (1974), Howard (1974), Pianka and Parker (1975). Ecological information is in Hodges (2009). Anecdotal information on *P. coronatum* reproduction is in many sources: (Smith, 1946; Stebbins, 1954, 2003; Parker 1973; Behler and King, 1979; Williamson et al., 1994; Degenhardt et al. 1996; Brennan and Holycross, 2006.). In this note, I report on a histological examination of *P. cornutum* gonadal material from New Mexico.

Methods.

A sample of 59 *P. cornutum* collected in New Mexico, USA (Appendix) and consisting of 27 adult males (mean SVL = 81 mm ± 9.2 SD, range = 64-98 mm), 17 adult females (mean SVL = 99.8 mm ± 4.6 SD, range = 90-110 mm), 2 subadult males (mean SVL = 60.5 mm ± 3.5 SD, range = 58-63 mm), 9 subadult females (mean SVL = 73.5 mm ± 5.0 SD, range = 53-95 mm), 4 neonates (mean SVL = 30.8 mm ± 6.4 SD, range = 24-38 mm) were examined. Specimens had been deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California USA. *Phrynosoma cornutum* were collected 1947 to 1962.

The snout-vent length (SVL) of each specimen was measured in mm from the tip of the snout to the posterior margin of the vent. The left gonad was removed and embedded in paraffin. Histological sections were cut at 5 μm and stained with hematoxylin followed by eosin counterstain (Presnell and Schreibman, 1997). Enlarged follicles > 4 mm length and oviductal eggs were counted. No histology was performed on them. Histology slides were deposited at LACM. An unpaired *t*-test was used to compare *P. cornutum* male and female mean body sizes (SVL) using Instat (vers. 3.0b, Graphpad Software, San Diego, CA).

Results.

Three stages were present in the testicular cycle of *P. cornutum* (Table 1): (1) regressed, seminiferous tubules contain spermatogonia and Sertoli cells; (2) recrudescence, a proliferation

of germ cells for the next period of sperm formation is underway, primary and secondary spermatocytes predominate; (3) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. The period of sperm production encompassed April to June. The smallest reproductively active male (spermiogenesis) (LACM 4262) measured 64 mm SVL and was collected in April. This is a new minimum size record for reproduction of male *P. cornutum*. Howard (1974) previously reported a minimum size of 72 mm SVL for mature *P. cornutum* males.

The mean of the female *P. cornutum* sample was significantly larger than that of the male sample (unpaired t-test, $t = 7.77$, $df = 42$, $P < 0.0001$). Four stages were present in the ovarian cycle (Table 2): (1) quiescent, no yolk deposition; (2) early yolk deposition, basophilic vitellogenic granules in the ooplasm; (3) enlarged follicles > 5 mm present; (4) oviductal eggs present. The period of reproductive activity encompassed April to July. There was no suggestion (concurrent yolk deposition in a female with oviductal eggs) to suggest a second egg clutch is produced in the same year. Vitt (1977) found no evidence of multiple clutch production in the seven *P. cornutum* females he examined. However, in view of the four month period of female reproductive activity (April to July), it might be possible. The smallest reproductively active female (follicles > 5 mm) measured 98 mm SVL (LACM 133245) and was collected in April. My female sample size was too small to give a meaningful minimum size for maturity, however, the range of reproductively active *P. cornutum* females in Texas was 68-105 mm (Ballinger, 1977). Clutch size (n = 3) was 18.3 ± 4.5 SD, range = 14-23. Two neonates (LACM 19695, SVL = 27 mm) and (LACM 101518, SVL = 24 mm) were collected August 16, and 17 respectively. One (SVL = 34 mm) collected August 31 (LACM 19751) was probably born earlier in the year. One (LACM 182003) collected May (SVL = 38 mm) was likely born the previous summer.

Table 1. Monthly stages in the testicular cycle of 27 *Phrynosoma cornutum* from New Mexico.

Month	N	Regressed	Recrudescence	Spermiogenesis
April	4	0	1	3
May	8	0	0	8
June	1	0	0	1
July	5	4	1	0
August	8	3	5	0
September	1	0	1	0

Table 2. Monthly stages in the ovarian cycle of 17 *Phrynosoma cornutum* from New Mexico.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 5 mm	Oviductal eggs
April	1	0	0	1	0
May	1	0	0	1	0
June	1	0	1	0	0
July	4	3	0	0	1
August	8	8	0	0	0
September	2	2	0	0	0

Discussion.

All species of *Phrynosoma* from the American southwest are spring breeders (see Jones and Lovich, 2009). By following a regimen of spring breeding, eggs are deposited in late spring or early summer, young emerge in summer and have several months to feed and grow before entering hibernation. An apparent exception, from Sonora, Mexico is *Phrynosoma ditmarsi* which produces sperm during autumn (Montanucci, 1989; Goldberg, 1999).

Acknowledgment.

I thank G. Pauly (LACM) for permission to examine *P. cornutum*.

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Biology Department, Whittier College, PO Box 634, Whittier, CA 90608, sgoldberg@whittier.edu
[1]Correspondence Author (lemos@unam.mx)
[2]Present Address: Department of Biology, Rice University, Houston, Texas 77251

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Appendix.

Phrynosoma cornutum from New Mexico examined by county from the Natural History Museum of Los Angeles County (LACM), Los Angeles, California.

Chaves LACM 4256; **Dona Aña** LACM 4251-4255, 4259-4261, 101514, 113424, 113425, 133244-133246; **Grant** LACM 101515; **Hidalgo** 76435, **Luna** LACM 101518-101523, 113426, 182002, 182003, 182004, 182006, 182007; **Sierra** LACM 4250, 76418 , 101524; **Socorro** LACM 19695, 19724-19739, 19741, 19743, 19745-19752, 19754, **Union** LACM 4262.

Seasonal Activity, Reproduction, and Growth to Sexual Maturity in the Green Frog (*Lithobates clamitans melanotus*) in South-Central Pennsylvania: Statewide and Geographic Comparisons

Walter E. Meshaka, Jr.

Abstract.

Data from field surveys during 2002-2003 and from 217 specimens of Green Frogs collected during 2008-2009 were used to examine seasonal activity, reproduction, and growth of the Green Frog (*Lithobates clamitans melanotus*) from a single wetland in south-central Pennsylvania. Terrestrial activity was observed during each month in combined years of the April-October study periods. Breeding season, as measured by months of calling and monthly frequencies of gravid females, was during May-July although breeding in late April and August cannot be ruled out. Clutch size averaged 3,070 eggs. Sexual maturity was reached in less than one year of post-metamorphic life in both sexes, and occurred earlier and at smaller body sizes in males. Likewise, mean and maximum adult body size was smaller in males than females at this site. Seasonal activity and breeding season reported in south-central Pennsylvania were in general agreement with those reported for Pennsylvania generally, whereas aspects of growth and maturity measured in this study differed sharply from those of Pennsylvania generally. Compared with populations elsewhere in the United States, most life history traits examined in this population typified those of northern populations and underscored the life history variability in this geographically widespread North American frog.

Introduction.

The Green Frog, *Lithobates clamitans melanota* (Rafinesque, 1820) is one of two recognized subspecies of the eastern North American Bronze Frog, *L. clamitans* (Latreille, 1801). Occurring throughout much of the eastern United States and southeastern Canada, it intergrades with the Bronze Frog, *L. c. clamitans* (Latreille, 1801), along the fall line in Georgia and Alabama (Conant and Collins, 1998; Pauley and Lannoo, 2005).

Besides differences in color pattern in the two forms (Mecham, 1954), geographic variation exists in various life history traits such as larger body size of adults (Wright and Wright, 1949; Mecham, 1954; Meshaka et al., 2009a,b, 2011) and metamorphoslings (Wright and Wright 1949; Meshaka et al., 2009a,b, 2011) in the North, and longer breeding seasons (Pauley and Lanoo, 2005; Meshaka et al., 2009a,b, c, 2011) in the South. In this study, I examined the aforementioned traits in the Green Frog from a single site in south-central Pennsylvania to ascertain the extent to which these geographic patterns applied to frogs at this location, approximately midway between the northern and southern limits of the species.

Study Sites and Methods.

The study site is located at Wildwood Park (WP), a 93.5 ha county park in Harrisburg, Dauphin County. Isolated by highways, the park is surrounds an artificial lake that comprises over 60% of an otherwise heavily forested park of mixed deciduous trees. Seasonal activity was determined using two methods. The first consisted of 25 nighttime surveys during June-October 2002 and April-May 2003 along a c.a. 1 km portion of a path, which was bordered by a canal on one side

Key words: Geographic variation, green frog, life history traits, reproduction

and the wetland on the other. Opportunistic collections of animals at night during April-October of both 2008 and 2009 in the park provided a general trend of which segments of the populations were active on land at the time.

Calling activity was noted during regular surveys and opportunistic collections. Air temperature and relative humidity, measured with use of a sling psychrometer, was recorded only during the 2002-2003 surveys. Sexual maturity was determined in males using a slightly modified version of the technique by Martof (1956), whereby the ratio of tympanum diameter: body size corresponded to enlarged testis, which signified sexual maturity. Martof (1956) noted that the tympana generally were "nearly or quite round". For most frogs Martof (1956) measured the antero-posterior diameter of the left tympanum. If irregular in shape, the right tympanum was measured. If both were misshapen, Martof (1956) took the average of the antero-posterior and dorso-ventral measurements. Irregularly shaped tympana from our sample were greater in length than in height. For consistency, we measured the dorso-ventral diameter of the left tympanum and used the right tympanum only if the left one appeared to have been damaged in some way. As per Martof (1956), sex index = body length/ tympanum diameter. The sex index was generally below 10 for sexually mature males (Martof, 1956).

The secondary sexual characteristic of enlarged thumbs was not easily ascertained in small males. The yellow throat of mature males, which easily fades to varying degrees in preservative, was not apparent. The length and width of the left testis as a percent of the body size in snout-vent length (SVL) was used to measure monthly differences in testis dimensions.

Sexual maturity in females was determined through dissection, and was classified in one of four ovarian stages. In the first ovarian stage oviducts were thin and relatively straight, and the ovaries are somewhat opaque. In the second ovarian stage, the oviducts were larger and more coiled, and the ovaries contained some pigmented oocytes. In the third ovarian stage, oviducts were thick and heavily coiled, and the ovaries were in various stages of clutch development. In the fourth ovarian stage, oviducts were thick and heavily coiled, and the ovaries were full of polarized ova with few primary oocytes, signifying a fully ripened clutch and gravid female. These categories, first used in Meshaka (2001), have been used in subsequent studies on the Bronze Frog (Meshaka et al., 2009a,b,c; Meshaka et al., 2011). Fat body development was scored as absent, intermediate in volume in the body cavity, to extensive development that reached upwards in the body cavity. The latter amount was used as an estimation monthly incidence of extensive fat relative to all females examined in each month. Likely cohort groupings in monthly distribution of body sizes were used to estimate growth rates.

All specimens were stored in the Section of Zoology and Botany of the State Museum of Pennsylvania, Harrisburg. Means were followed by $\pm$ 1 standard deviations. T-tests were used to compare mean values, and F-tests were used to compare variances, between samples. Statistical differences were deemed significant at $P < 0.05$.

Results.

Seasonal activity. Green Frogs were active on land as early as April and as late as October (Figures 1&2). During 2002-2003, the earliest record of active individuals was on 8 May 2003 (Figure 1). No frogs were seen on visits immediately prior to that date of 17 and 18 April 2003. Latest record of active individuals was on my first October visit of 10 October 2002. I saw no frogs on the next and last visits of 13 and 15 October 2002. Opportunistic captures on land during 2008-2009 reflected an initial surge of breeding males and females in May, followed by a greater drop-off of males than females in June and July, presumably because of more time spent in the water by calling

males (Figure 2). The July-August increase in collections was comprised of more juveniles than seen in other months (Figure 2, 3). Active individuals were seen on 1 April 2009 and 9 September 2008, the first and last search dates of active animals respectively. Two juveniles were found under large rocks along a stream on 22 October 2008 (Figure 3)

Seasonal changes in testis size. Measured as a percentage of male body size, greatest testes lengths were apparent in July and August, whereas testes were greatest in width by June (Figure 4).

Calling. Green Frogs were heard calling at night during May-August at Wildwood Park and most noticeably in June-July. No calling was heard on the evenings of 17 or 18 April 2003. Consequently, late April calling cannot be ruled out. A calling season of May-August typified that during subsequent collections. Because April visits were early in 2008 (11 April) and 2009 (1 April), late calling in April of those years, likewise, cannot be ruled out. Calling was heard when the air was warm (mean = 20.1 ± 3.0 °C; range = 15.3-25.1; n = 14) and humid (91.1 ± 8.4 %RH; range = 76-100; n = 14).

Ovarian cycle. Gravid (stage 4) females were detected during May-July (Figure 5). Yolking-nearly gravid (stage 3) females were captured during 11 April- 9 September (Figure 5). High frequencies of stage 2 and 3 females and low frequencies of stage 1 females were found in August (Figure 5). An opposite pattern was evident in September, and stages 1 and 3 predominated in April (Figure 5). These patterns indicated a gravid condition during May-July, and possibly so in late April through mid September.

Clutch size (mean = 3,070 ± 201.9 eggs) was estimated for five females which, presented below, are followed in parentheses by the clutch size and largest oval diameter from a series of 10

Figure 1. Seasonal activity of the Green Frog *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, from 25 nocturnal visits during June-October 2002 and April-May 2003.

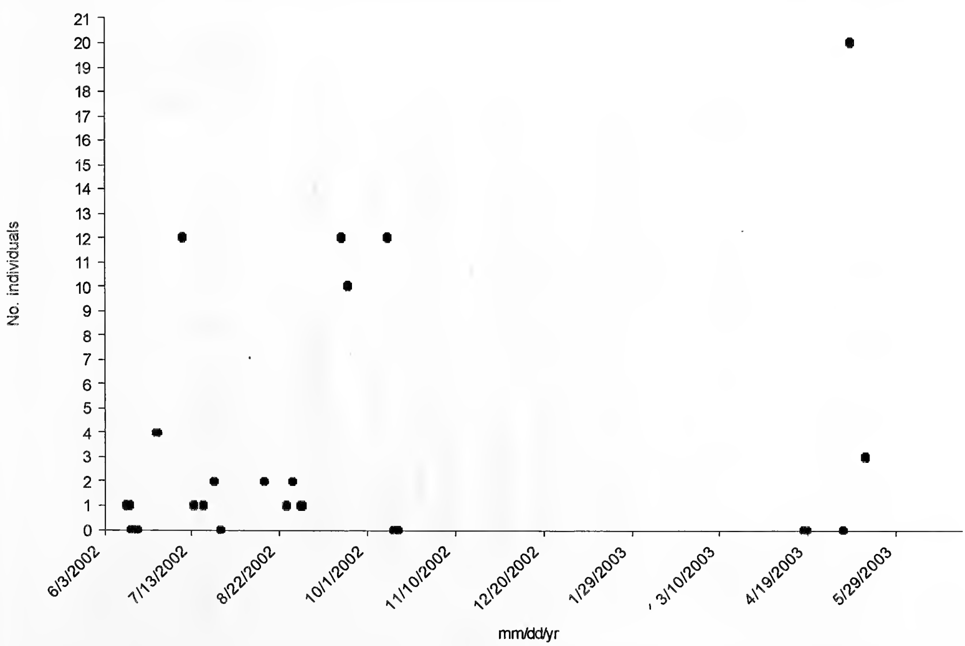


Figure 2. Monthly incidence of captures of 217 Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.

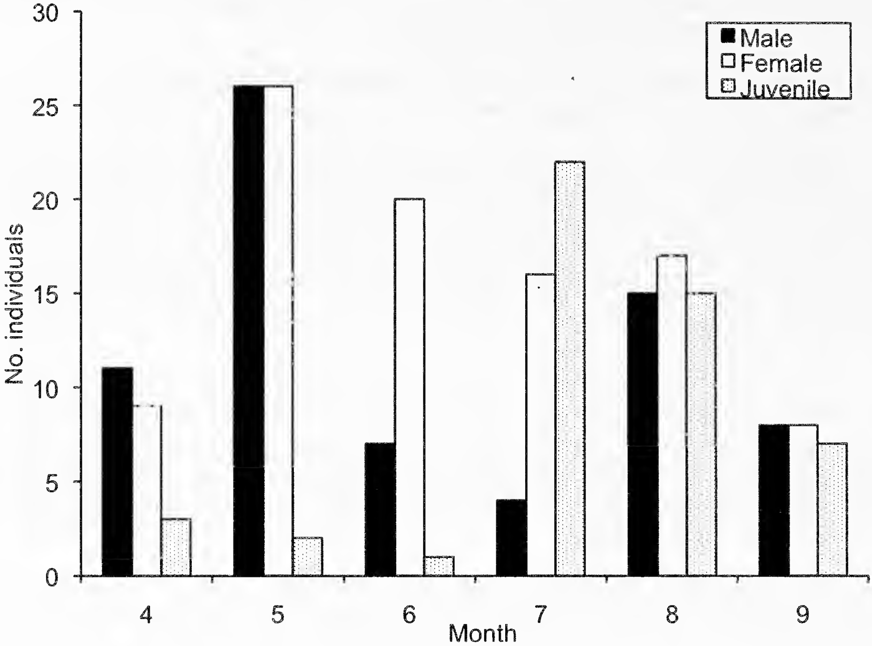


Figure 3. Monthly distribution of body sizes of 217 Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.

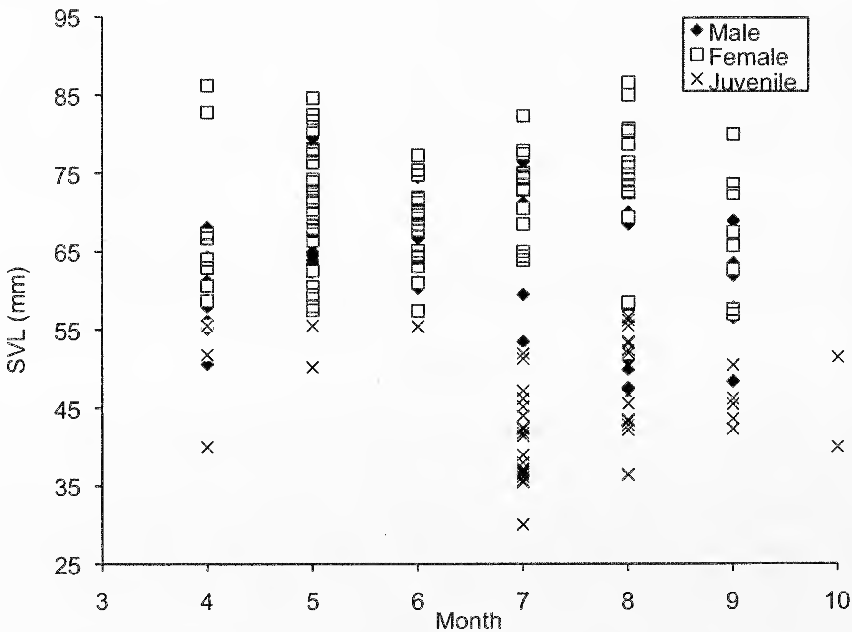


Figure 4. Monthly distribution of testis size as a percentage of body size of 71 Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.

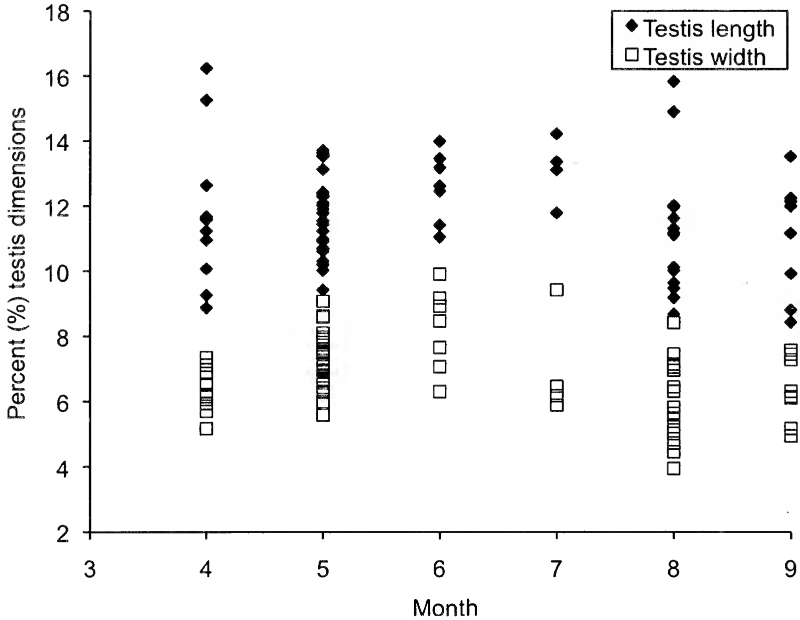
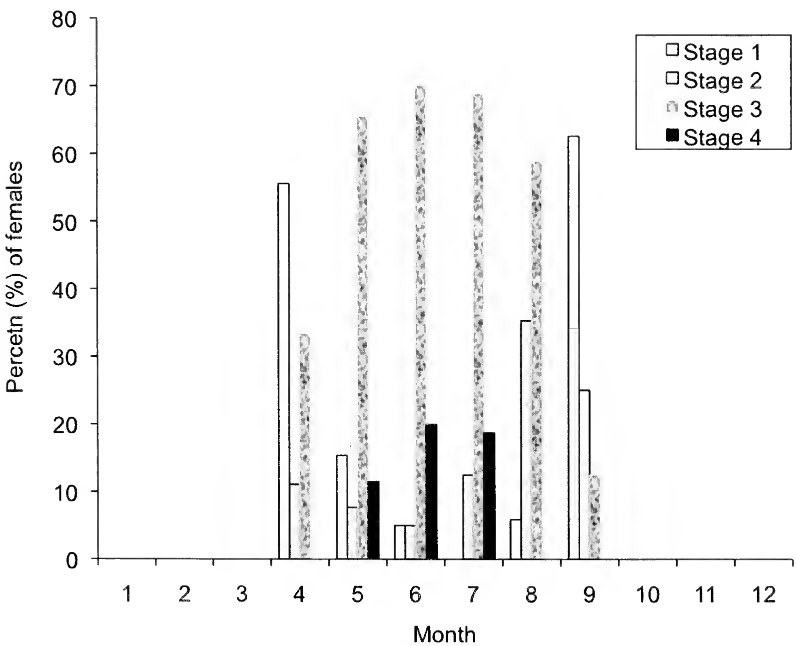


Figure 5. The annual ovarian cycle of 96 Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.



ova/female: 74.4 mm SVL (2,750/ 1.6 mm), 77.5 mm SVL (3,100/ 1.6 mm), 80.5 mm SVL (3,150/ 1.7 mm), 81.7 mm SVL (3,050/ 1.6 mm), and 84.6 mm SVL (3,300/ 1.6 mm).

Female fat cycle and the presence of food. The extent to which fat bodies were well-developed in females varied across the months, such that depletion of winter stores of fat began in May and was completed in July (Figure 6). These months coincided with those of gravid females (Figure 5), all of which were depleted of their fat compared to many of their non-gravid counterparts (Figure 7). The incidence of females containing food in their stomachs was nearly evenly high during April-September (Figure 6) and was high regardless of reproductive condition (Figure 7).

Growth and sexual maturity. Metamorphoslings from Pennsylvania averaged 29.7 mm in snout-urostyle length (Hulse et al., 2001). Using this value, growth trajectories from the monthly distribution of body size (Figure3) indicated that male Green Frogs at Wildwood Park reached sexual maturity at two months of post-metamorphic age at 42.7 mm SVL. Males attained their mean adult body size at approximately 10-11 months of post-metamorphic age at 62.8 ± 8.2 mm SVL; range = 42.7-79.5; n = 71).

Mean sex index (body length/tympanum) for 71 male Green Frogs was 7.8 ± 1.0 mm (range = 5.7–9.7) and the sex index negatively co-varied with male body size (Figure 8). The reason for this inverse relationship was because the tympanum diameter, which co-varied with body size of adult males (Figure 9), was relatively larger in large males (Figure 10).

The smallest sexually mature female (ovarian stage 1) reached sexual maturity at 11 months of post-metamorphic age at 57.0 mm SVL (n = 11) (Figure 3). The smallest gravid female

Figure 6. Monthly frequency of extensive fat and the presence of food in 96 female Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.

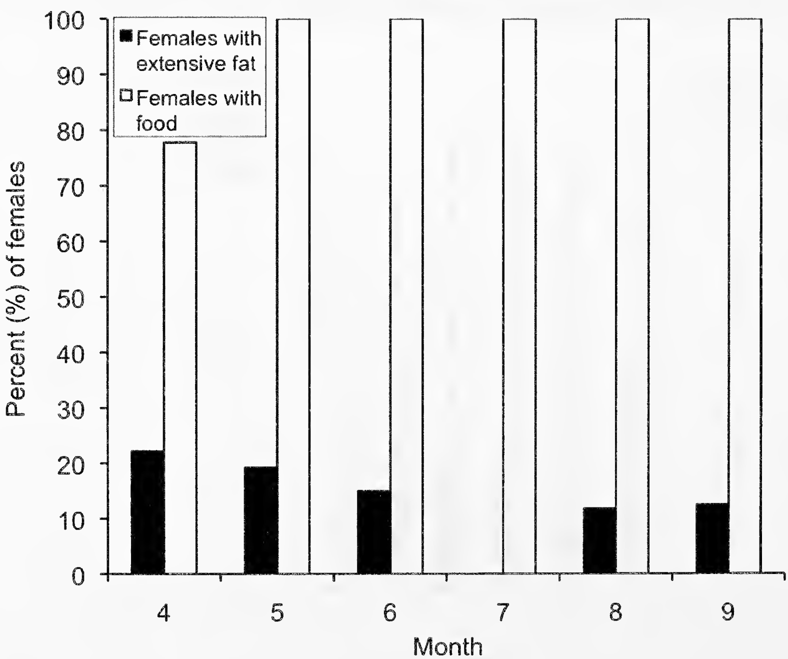


Figure 7. Frequency of extensive fat and the presence of food in each of the four ovarian stages of 96 female Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.

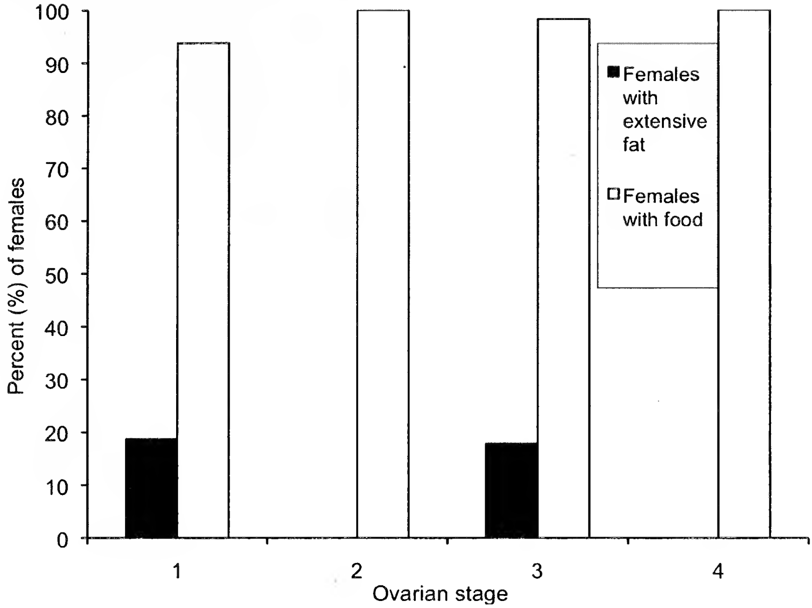


Figure 8. The relationship between sex index and body size of 71 male Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.

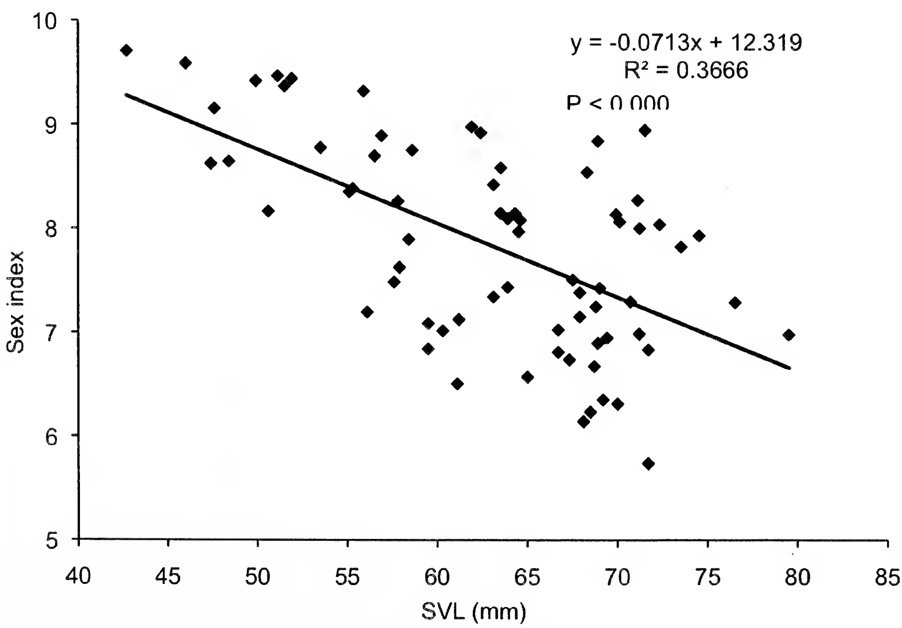


Figure 9. The relationship between tympanum diameter and body size of 71 male Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.

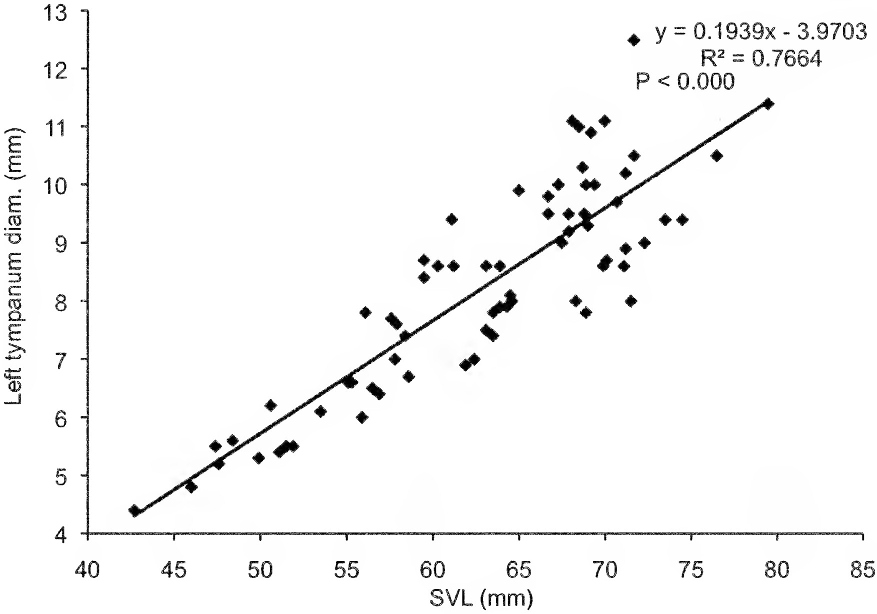
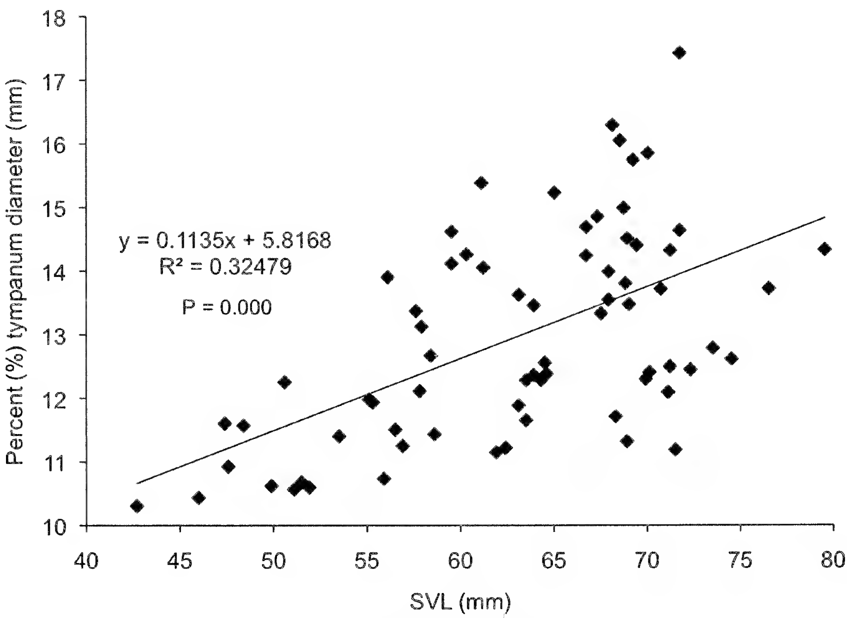


Figure 10. The relationship between tympanum diameter as a percentage of body size and body size of 71 male Green Frogs *(Lithobates clamitans melanota)* from Wildwood Park, Dauphin County, Pennsylvania, during 2008-2009.



measured 64.4 (n = 10), and was larger than the smallest females of ovarian stages 2 (59.5 mm SVL) and 3 (61.0 mm SVL). Mean body size for all sexually mature females was 71.0 ± 7.2 mm SVL (range = 57.0-86.6; n = 96) mm SVL and was associated with an age of approximately 13-14 months of post-metamorphic life. Mean body size of adult females differed significantly (T = 1.654; df = 165; $P < 0.0001$) from that of adult males.

Body sizes of gravid females (mean = 76.3 ± 5.7 mm SVL; range = 64.4-84.6; n = 10) differed significantly in mean (t = 1.661; df = 94; p = 0.007) from those of non-gravid females (ovarian stages 1-3) (mean = 70.4 ± 7.2 mm SVL; range = 57.0–86.6; n = 86).

Discussion.

This study provided site-specific natural history information on a ubiquitous but under-studied member of the native Pennsylvania herpetofauna. Findings from this study were in general agreement with those of this species from Pennsylvania generally (Hulse et al., 2001), with several exceptions. At WP, individuals could be terrestrially active from at least April-October. The monthly distributions of observations indicated that a longer active season could not be ruled out, especially earlier dates. For Pennsylvania generally, individuals were found to be active during mid-March through October or early November (Hulse et al., 2001). Winter dormancy at WP was typical of other northern populations such as those of West Virginia (Meshaka et al., 2009c) and New England (Klemens, 1993), whereas activity throughout the year occurred farther south in Louisiana (Meshaka et al., 2009a,b) and Texas (Meshaka et al., 2011).

Calling at WP was heard during May-August, which overlapped the months of overall greatest testes dimensions and evidence of gravid females during May-July. Taken together, egglaying was most probable during May-July at WP during the combined two years of this study, although, April and August reproduction could not be ruled out. These findings, like the observation of breeding from the end of April or early May through part of August for Pennsylvania generally (Hulse et al., 2001), conformed to the breeding season noted for populations of northern and intermediate latitudes (Pauley and Lannoo, 2005).

Air temperatures associated with calling at WP were within the range reported for West Virginia (17.9 °C) (Meshaka et al., 2010b) and Texas (24.4 °C) (Meshaka et al., 2011). As elsewhere (e.g., Meshaka et al., 2009c, 2011), males at WP were heard when the air was also humid. Mean ovarian clutch size from females at WP fell within the lower range of clutch size as estimated by number of eggs in egg masses reported for Pennsylvania generally (Hulse et al., 2001). This comparison is tenuous because of the small sample size at WP as well as an absence of body size data for the females that laid the egg masses counted by Hulse et al. (2001).

Growth to sexual maturity occurred quickly for both males and females at WP, with both sexes capable of breeding for the first time in less than one year after larval transformation. Comparatively, Hulse et al. (2001) reported that Green Frogs reached sexual maturity by the beginning of their second full growing season, later than estimated for WP. Estimates of age at sexual maturity can vary depending in part on the minimum body size at sexual maturity, and on this point differences between the samples exist.

Based upon the sex index, which relates the disproportional increase in tympanum diameter in Michigan males (Martof, 1956), males at WP were sexually mature at body sizes (42.7 mm SVL) having enlarged testes. A sex index generally below 10 that typified sexual maturity in males and a negative relationship between sex index and body size (Martof, 1956; this study), was also apparent in Bronze Frogs in Louisiana (Meshaka et al., 2009a,b) and Texas (Meshaka et al., 2011), and Green Frogs in West Virginia (Meshaka et al., 2009c).

The minimum body size at sexual maturity of Wildwood Park males was well below the 60-63 mm SUL as reported by Hulse et al. (2001) for males across Pennsylvania and this difference cannot be explained by differences in body length measurement technique. From the sample in this study, nuptial pads were not evident in males smaller than 60 mm SVL; however, this character was not used as a criterion because of the possibility that nuptial pads were more difficult to see in smaller males or are disproportionately smaller in small males. Tympana in small males were also still relatively larger than those in females. Although both tympanum diameter and nuptial pad development are measures of sexual maturity, tympana could still be measured whereas nuptial pads development could be less obvious and could be difficult to quantify. If sexual maturity is a gradual process, then males at WP with enlarged tympanum diameter and concomitant enlarged testes were doubtlessly fertile even if the likelihood of successful mating was all but reserved for larger-bodied males. If sexual maturity was not determined by nuptial pad development in the study by Hulse et al. (2001), then comparisons between the two values are difficult to make because the sample size or the region of Pennsylvania from which those specimens were taken are not known. The minimum of 60 mm SVL could be achieved by WP males before the beginning of the second full season of growth.

The same difference in minimum body size at sexual maturity applied to females. Whereas females at WP were clearly fertile by c.a. 60 mm SVL, the smallest sexually mature females examined by Hulse et al. (2001) measured about 70 mm SUL. As in the case of males, the circumstances of the Hulse et al. (2001) collection precluded determining the cause of the differences between the two female samples.

Regardless of the reasons for the disparity in minimum body sizes at sexual maturity between both sexes of this sample and those of Hulse et al. (2001), the smaller adult body size minima of this sample in turn were reflected in smaller mean values of adult body sizes than those of Hulse et al. (2001). To that end, males and females of WP averaged 62.8 and 71.0 mm SVL, respectively, whereas those of Hulse et al. (2001) measured 86.1 and 85.5 mm SUL, respectively. Likewise, sexual dimorphism in adult body size was pronounced in Green Frogs from Wildwood Park and essentially non-existent in the sample examined by Hulse et al. (2001).

Males of this study were more similar to southern populations with respect to age (see Meshaka et al., 2009a for summary; Meshaka et al., 2009c) and body size at sexual maturity (Meshaka et al., 2009a,b; Meshaka et al., 2010a), but were intermediate between northern and southern populations (op. cit.) with respect to mean adult body size.

Among females of this study, the age at sexual maturity, minimum body size at sexual maturity, and mean adult body size were more similar to those values of other northern populations (Wright and Wright, 1949; Mecham, 1954; see Meshaka et al., 2009a for summary; Meshaka et al., 2009c), as compared to the early-maturing small-bodied females typical of southern populations.

Many, but not all, of the findings of this study adhered to geographic patterns in the life history traits associated with this species along a north-south gradient. Differences underscore the importance of site-specific studies to both understand the flexibility in life history traits particularly of such geographically widespread species as the Green Frog and to use those findings when formulating comprehensive wetland management plans.

Acknowledgments.

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Section of Zoology and Botany, State Museum of Pennsylvania,
300 North Street, Harrisburg, PA 17120

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Another Yellowbellied Slider (*Trachemys scripta scripta*) from Maryland

Arnold Norden and Mike Browning

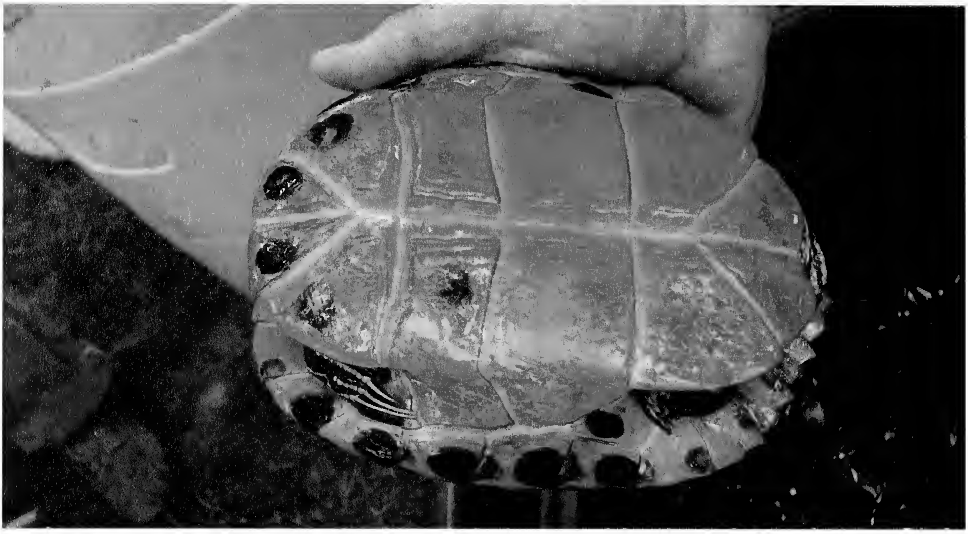
On June 21, 2012 a series of aquatic turtles were collected at Gunpowder Falls State Park in Baltimore County, Maryland by park staff. They were captured in baited hoop traps to be used in a demonstration, and then released. The capture site was a shallow, slow moving tidal tributary flowing into Cunninghill Cove, which joins the lower Gunpowder River at the Hammerman Area of Gunpowder Falls State Park. The traps yielded several sliders (*Trachemys scripta*), numerous eastern painted turtles (*Chrysemys p. picta)*, several eastern mud turtles (*Kinosternon s. subrubrum*) and a few large snapping turtles (*Chelydra serpentina*).

The red-eared slider (*Trachemys s. elegans*) is the common large basking turtle in this area and is frequently seen on logs and taken in turtle traps or nets. On this day two adults were selected at random and brought back to the park. Upon examination it was immediately obvious that only one, an adult female, was *T. s. elegans*. The second individual was a mature male *T. s. scripta*. The turtle measured 7 12/16 inches (19.7 cm) along the curve of the carapace. After the demonstration it was photographed (Figure 1) then released at the point of capture.

Although *T. s. elegans* has been widely introduced throughout much of Maryland (Harris 1975) there are only two previous reports of the distinctive subspecies *T. s. scripta.* The first was found at Little Falls on the Potomac River in Montgomery County (Cooper 1959, Reed 1956). Subsequently, Harris (2006) reported a dead individual found on New Cut Road in Anne Arundel County.

The natural range of *T. s. scripta* Includes the southeastern United States as far north as south eastern Virginia (Conant and Collins 1998), and these Maryland records probably represent individuals introduced during the heyday of the "dime store" turtle industry when tens of thousands of newly hatched aquatic turtles were sold as pets. While *T. s. elegans* was by far the most frequently exploited turtle, I recall seeing a number of other species and subspecies mixed in for

Figure 1. Dorsal and ventral views of adult *T. s. scripta* captured at Hammerman Area, Gunpowder Falls State Park, Baltimore County, Maryland.



sale at local outlets in Baltimore, including map turtles, western painted turtles, *Pseudemys* sp., and the occasional yellow-bellied slider. There is no reason to believe that this adult individual from Hammerman belongd to a reproducing population. It would be highly unlikely that a small population of *T. scripta scripta* could maintain its genetic identity in an area where large numbers of *T. scripta elagans* are breeding successfully.

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2H Northway Road, Greenbelt, Md 20770 (anguispira@aol.com).

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Breeding and Larval Growth of the Marbled Salamander, *Ambystoma opacum* (Gravenhorst, 1807), From Two Adjacent Sites in South-Central Pennsylvania

Abstract.

The breeding phenology of the Marbled Salamander (*Ambystoma opacum*) was examined during June 2011-June 2013 at adjoining temporary ponds at the Letterkenny Army Depot in south-central Pennsylvania. Breeding activity of the Marbled Salamander occurred during a brief period in the middle of September. Nesting sites were nearly exclusively in underground root cavities. Females were larger (66.4 mm) than males (61.6 mm) in mean body length and were not as brilliantly patterned or as numerous as males. Although adults migrated to both ponds, only one was suitable for breeding. Larvae transformed the following May after a larval period of 191 days. Inter-annual variation existed in mean metamorphic body size and frequency of injuries that might best be explained by larval intraspecific competition for food in a crowded breeding pool. Our findings corroborate geographic and local effects in the traits examined in this population of the Marbled Salamander. Our findings also underscore the possible implications of this salamander's novel choice of nesting sites in its larval growth rates, metamorphic body size, and estimates of abundance.

Introduction.

The Marbled Salamander, *Ambystoma opacum* (Gravenhorst, 1807), is one of five ambystomatid salamanders native to Pennsylvania (Meshaka and Collins, 2012) and whose range in Pennsylvania approaches the northeastern edge of its geographic distribution (Conant and Collins, 1998). Atypical of the genus, the Marbled Salamander, lays its eggs under cover in dry seasonal pools, and tends the eggs until the nest is inundated with water, after which time the female leaves and the eggs hatch (Kaplan and Crump, 1978; Petranka, 1998; Scott, 2005).

The biology of this species has received scant attention in Pennsylvania (Hulse et al., 2001) despite its presence in 19 counties in the Commonwealth (Meshaka and Collins, 2012). For Pennsylvania generally, breeding is initiated in the fall (Hulse et al., 2001). Larval period is approximately 135 days but varies according to environmental temperatures (Hulse et al., 2001). In central Pennsylvania, transformation has been reported during mid-June-early July (Hulse et al., 2001).

Breeding activity of the Marbled Salamander has been reported to occur progressively later in the year as one proceeds south in its range (Petranka, 1998; Scott, 2005). Rangewide, females nest under cover at the ground surface, they are larger in body size than males, less brilliantly marked, and generally not as numerous as males at breeding sites. Although the larval period can be affected by local effects, such as timing of rainfall to inundate the nest sites, larval periods are generally longest in the North, where larvae must overwinter, often under the ice. In turn, transformation dates are reported to occur earlier in the South (Petranka, 1998; Scott, 2005). Body size at transformation, is strongly influenced by local effects, such as food supply and water temperature (Petranka, 1998; Scott, 2005).

The objectives of our study were to determine the extent to which this species conformed to aforementioned geographic and local effects at two adjacent breeding sites at a protected research area in south-central Pennsylvania.

Methods and Materials.

This study took place during June 2011-June 2013 in two adjacent vernal pools, Missile Pond and North Pond, in Zone II of Letterkenny Army Depot (LEAD) in Franklin County, near

Chambersburg, Pennsylvania. Located in south-central Pennsylvania, LEAD occupies more than 7000 hectares of mixed deciduous forest, agricultural fields, grassland and various natural and artificial wetlands (Delis et al., 2010).

Both ponds were autumnal pools and 50 m from one another along the edge of a mixed deciduous forest bordering an unimproved road to the east. Natural surface cover, such as logs and flat rocks were scarce. Naturally formed holes of approximately 50 mm in diameter entering the ground were located primarily, but not exclusively, near the center of the ponds. Each pond typically remained dry continuously from June until sufficient rains began to fill the pools in October. Pools subsequently might or might not maintain water continuously thereafter. North Pond measured 260 m^2 at high water and 70 m^2 at low water. Missile Pond measured 275 m^2 at high water.

In addition to our periodic surveys, in September 2012, a paired combination of 15 91 X 30 cm rectangular roofing shingles and 15 small flat rocks were placed flat on the ground within each dry site as a three row by five column rectangular grid in an attempt to attract more females to lay their clutches. Within North Pond, the covers were placed 6.5 meters apart in the north-south axis and 6.2 m apart in the east-west axis. The covers were placed 6.5 m apart in the north-south axis and 5.0 m apart in the east-west axis within Missile Pond. The small difference in cover separation was the result of adjusting for the uneven distribution of woody plants within the two sites. The ground under the covers was split into two sections, and all organic matter was removed from each section until contact with mineral soil. At each point in the grid, a cover was placed on the north side of the cleared section, and a flat rock was placed on the south side of the cleared section, nearly touching the cover. Until covers were submerged in water, bi-weekly visits were made during the day to check for the presence of brooding females under both types of cover. Salamanders found within the dry autumnnal pool sites were captured by hand. Direction of entry was recorded, and individuals were sexed, assessed of reproductive condition (gravid or non-gravid), and their snout-vent lengths (SVL) were measured to the nearest cm by using a measuring tape. All individuals were cohort-marked by removing the fifth digit of the right hind foot with scissors before release.

Initial water levels in cm following November rains were recorded during each visit from the center of each pond. Thereafter, presence or absence of standing water was noted for each of the two ponds through the duration of the study.

Larval density was estimated by dip-netting at 10 different locations in the pond. The dip-net was swept 31 centimeters at each location. Water depth and number of larvae caught at each location was recorded. The volume of water that passed through the dip-net was found by multiplying the distance the dip-net was moved in cm by the length of the net in cm by the water depth in cm and converted to liters. The number of larvae caught at a sampled location of the pond was divided by the L of water passing through the dip-net to calculate the individuals/L. A mean was calculated for the no. individuals/L for all 10 sampled locations of the pool.

The total volume of water in the pond was estimated by calculating the surface area in dm^2, using the closest polygon, and multiplying it by a prorated average depth in dm ($1\ dm^3 = 1$ L). Total larvae density was estimated by multiplying the number of individuals/L by the estimated total volume of water in the pond. Total estimated number of larvae was divided by the total area of the pond to provide also an estimate of larvae density/m^2. The abundance of breeding females, who successfully nested in the pond, was estimated by dividing the total number of larvae by an average clutch size arbitrarily chosen as 80, which was the estimated clutch size of the singe female that we found attending a nest. This clutch size value is well between the general range of 50-200 eggs in a review provided by Petranka (1998). Our calculations assumed an optimal case scenario in which all females laid eggs, all the eggs hatched, and all larvae survived. Larval growth rate was estimated from apparent monthly age-body size cohorts in consecutive monthly body

size distributions of preserved larval body sizes as measured with hand calipers to 0.1 mm SVL. When measuring the preserved specimens, we noted the presence of nipped tails, missing limbs, or other signs of external body injury in larvae and metamorphic individuals. We used for statistical analyses, two sample t-tests, Chi-square, statistics of location and dispersion, as well as graphing capabilities, from Microsoft Excel.

Results.

Hydrology- Both ponds remained dry until 1 November 2012, when water depth measured 65 cm at Missile Pond and 25 cm at North Pond. No standing water existed in North Pond on 15 November 2012 and this pond remained dry until April and May 2013 and was dry once more in June 2013 at the end of the study. Missile Pond, on the other hand, maintained standing water, even if shallow (33.8 cm on 15 November 2012, 12.5 cm on 12 December 2012), through May 2013. Like North Pond, Missile Pond was dry in June 2013. During the course of our study, the LEAD was hit by Hurricane Sandy on 30 October, producing heavy rains but mostly patchy wind damage, including large tree downfalls. In spite of some large tree falls at both ponds, according to the before and after graphic data, this storm did not affect significantly affect the physical characteristics of the ponds.

Adult movements, numbers, and sex ratios- A total of 203 males and 36 females were found at Missile Pond. North Pond had a total of 43 males and three females. Missile Pond had a male: female sex ratio of 9.9:1 on 8 September 2012 and 3:1 on 18 September 2012. A combined sex ratio of 5.7:1 was significant ($x^2 = 9.800$, $p = 0.0017$). North Pond had a male: female sex ratio of 13.5:1 on 8 September 2012 and 16:1 on 18 September 2012. A combined sex ratio of 14.3:1 was significant ($x^2 = 34.783$, $p = 0.0001$).

Migration direction- At Missile Pond, the majority of males were moving eastward from the mountains on both 8 September 2012 (52.9%) and on 18 September 2012 (48.2%). From a combined sample of males from 8 September 2012 (n = 138) and 18 September 2012 (n = 83), 51.1% of the males were moving eastward, and only 44 and 64 males moving in the center and westward, respectively. From a combined sample of females from 8 September 2012 (n = 6) and 18 September 2012 (n = 24), 53.3% of the females were moving eastward and only six and eight females were moving in the center or westward, respectively.

At North Pond, the direction of 27 males was unknown on 8 September 2012. On 18 September 2012 we recorded the direction of 16 males: seven moving eastward, three in the center, six moving westward. Among seven females observed on 18 September 2012, one female was in the center of the grid, and six females were moving westward.

Adult size- Body sizes of adult males (mean = 61.6 ± 5.5 mm SVL; range = 45-74 mm; n = 203) were significantly smaller (6.3 %) (t-test, Two-Sample Assuming Unequal Variances *p* (one-tail) < 0.001) than females (mean = 66.4 ± 4.8 mm SVL; range = 60-80 mm; n = 36) from Missile Pond. Body sizes of adult males (mean = 61.1 ± 6.9 mm SVL; range = 42-71 mm; n = 43) appeared to be smaller in size (5.6 %) than females (mean = 64.7 ± 2.5 mm SVL; range = 62-67 mm; n = 3) from North Pond; however, the sample size was not large enough to test for statistical significance. Male body sizes were not significantly different (t-test, Two-Sample Assuming Equal Variances *p* (one-tail) > 0.05) between Missile Pond and North Pond.

Use of cover boards- On 26 September 2012 at Missile Pond, a male was found under a cover in the east axis of the grid, peeking out of a small hole in the ground, and a single female was found guarding her clutch under a rock placed within the western axis of the cover grid. These two finds represented a 6.7 % occupancy rate for covers and rocks. Diurnal searches revealed few

males and no females under the sparse natural cover. No salamanders were found using the cover grid in North Pond.

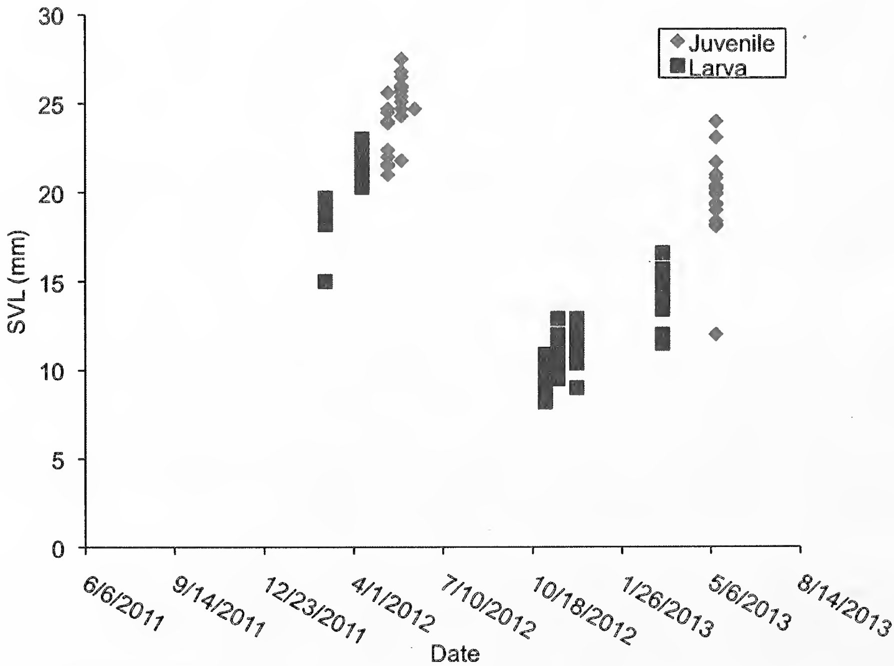
Estimation of larvae density and number of breeding females- Larval density at Missile Pond was estimated to be 2.11 individuals/L with a total estimated larval abundance 11,955 individuals or 43.6 larvae/m2 on 13 December 2012. No larvae were found in North Pond. Female abundance was estimated at 149 females at Missile Pond.

Frequency of injury- We found 32.5% of larvae and 38.0% of metamorphic individuals showed signs of injury during 2011-2012. At the same site during 2012-2013, we found 42.0% of larvae and 45.0% of metamorphic individuals showed signs of injury.

Larval growth rate and transformation dates- Monthly distribution of body size (SVL) of larvae and metamorphic individuals differed between both years (Figure 1). During the last few months of growth (70 days), larvae grew 0.073 mm/day (= 2.19 mm/mo) from a mean value of 17.8 mm (std = 2.0; range = 15.0-19.7; n = 7) on 29 February 2012 to metamorphic mean body size of 22.9 mm (std = 1.6; range = 21.0-25.6; n = 12) on 9 May 2012. Although few Spotted Salamanders (*Ambystoma maculatum*) had been observed in this pond in prior years (PRD, pers. obs.), no adult or larvae of other competitor salamanders were captured during this study at either site.

The larval period was estimated to have been 191 days, during which the larvae grew 0.053 mm/day (= 1.59 mm/mo) from a mean value of 9.8 mm (std = 0.8; range = 8.2-10.9; n = 19) on 1 November 2012 to metamorphic mean body size of 19.9 mm (std = 2.4; range = 12.0-24.0;

Figure 1. Monthly distribution of body sizes of 96 larval and 45 metamorphic Marbled Salamanders *(Ambystoma opacum)* from Missile Pond, Chambersburg, Franklin County, Pennsylvania, during 29 February 2012-11 May 2013.



n = 20) on 11 May 2013. During the last few months of growth (60 days), larvae grew 0.093 mm/ day (= 2.79 mm/mo) from a mean value of 14.3 mm (std = 1.4; range = 11.5-16.6; n = 19) on 12 March 2013 to metamorphic mean body size on 11 May 2013.

Annual variation of metamorphic body size- Body sizes of metamorphic individuals in 2012 (mean = 24.2 ± 1.9 mm SVL; range = 21-27.5 mm; n = 25) were significantly larger (F = 0.63927, t-test, Two-Sample Assuming Equal Variances *p* (one-tail) < 0.0001) than those in 2013 (mean = 19.9 ± 2.4 mm SVL; range = 12-24.5 mm; n = 20).

Discussion.

Geographic effects were apparent in several reproductive traits of the Marbled Salamander examined in our study. Across its geographic range, movements by the Marbled Salamander to breeding sites, timed with cool and wet conditions, varies geographically such that northern populations move earliest in the season (Petranka, 1998: Scott, 2005). As in other northern populations, like Connecticut (Klemens, 1993) and New Jersey (Anderson and Williamson, 1973), individuals at our study site migrated in September. In southeastern New York, oviposition occurred during late September- early October (Bishop, 1941). Farther south, breeding occurred during October-November in Arkansas (Trauth et al., 1989) and Alabama (Mount, 1975), November in South Carolina (Anderson and Williamson, 1973), and during late October-early December in Louisiana (Dundee and Rossman, 1989).

Larval transformation dates were also subject to geographic trends, whereby larvae transformed later in the season in northern populations (Petranka, 1998). Our data (May) and those from central Pennsylvania (mid-June- early July) (Hulse et al., 2001) conformed to that pattern. Larvae transformation has been reported to occur during June-July in Connecticut (Klemens, 1993), during May-early July in New York (Deckert, 1916; Bishop, 1941), during mid-May-mid-June in southern Indiana (Minton, 2001), in May in Maryland (Worthington, 1968, 1969) and Arkansas (Trauth et al., 1989), late March-mid-June in central North Carolina (Stewart, 1956), and during March-April in Louisiana (Dundee and Rossman, 1989).

The length of the larval period is generally longer in the North because of cold winter conditions that slow the growth rate (Petranka, 1998), but could vary somewhat in the South where three to four months can pass between oviposition and inundation (Petranka and Petranka, 1981). For example, in Arkansas the larval period was 90 days after eggs that were laid in the fall hatched February (Trauth et al., 1989). In the North, larval periods remained longest, such as 240-270 days in New York (Bishop, 1941; Deckert, 1916) and 191 days at our study site. In Louisiana, the larval period ranged 120-180 days (Doody, 1996).

Adult body size and sexual dimorphism in body size of the Marbled Salamander at our study sites were within the range of values for other sites (e.g., Trauth et al., 1989; Minton, 2001). Exceptionally, mean adult body size of both sexes were smaller in Connecticut (Klemens, 1993), and we do not know the reason for this disparity.

Typical of the species rangewide, sex ratios at our breeding sites were consistently biased to males. For example, male: female sex ratios ranged 6:1-85:1 in South Carolina (Krenz and Scott, 1994) and 3.3:1 in North Carolina (Stenhouse, 1987). Whereas in terrestrial habitat, a 1:1 sex ratio was found among 18 adults in southern Illinois (Parmerlee, 1993). Our conservative estimate of 149 breeding females corroborates the notion that the actual sex ratio was closer to unity than estimated from breeding sites where males remained conspicuous and females did not linger above ground after mating.

Larval densities can affect larval growth rate and the body size and survival of metamorphic individuals (Petranka, 1998), and water temperatures can affect larval growth rate (Stewart, 1956; Doody, 1996). Larval growth rates at our study site were considerably slower (< 3.0 mm/mo) than measured in Louisiana (6.9 mm/mo) (Doody, 1996), Kentucky (5.7 mm/mo) (Keen, 1975), and New Jersey (7.9 mm/mo) (Hassinger et al., 1970). Likewise, mean body sizes at transformation at our site was smaller (mean = 19.9 mm, 24.2 mm) than mean values of 30 mm in Arkansas (Trauth et al., 1989), 34 mm in Kentucky (Keen, 1975), and 38 mm in New Jersey (Hassinger et al., 1970). Between years, larvae grew slower and transformed at smaller body sizes in 2013 than in 2012. The frequency of injured larvae and metamorphic individuals was higher in 2013 than in 2012. Larval density, although not estimated in 2012, was high in 2013 and comparable to the estimated high density of 47 larvae/m^2 reported by Smith (1988). Frequency of injury is known to be affected by body size of individuals, competition mechanisms, and kinship as well as food level (Petranka, 1998). We also report here densities in individuals per liter, which in our opinion, is a more objective and comparable unit, because it accounts for differences in depth and variation in benthic habitat complexity. Thus, it cannot be ruled out that Missile Pond was less limiting in subterranean nesting sites than it was in larval food, contributing to slow-growing larvae and stunted metamorphic individuals generally, the body lengths of which varied between years. Indeed, far more females were able to nest at Missile Pond because of what appeared to be a novel ability to exploit subterranean retreats to the exclusion of scarce natural covers and near exclusion of artificial surface covers. At the same time that these retreats could provide males with temporary protection from predators, nesting females with more choices for nests and protection from many predators of nesting females and eggs, they could also be a source of larval overcrowding, a contributing factor to the phenomenon of slow-growing stunted metamorphic individuals. Subterranean nesting by the Marbled Salamander, although not mentioned in the literature (Petranka, 1998; Scott, 2005), is not unique to our site as it has been observed in other ponds in south-central Pennsylvania (EW, pers. obs.). Consequently, in the management of this species, at least in south-central Pennsylvania, it must be recognized that failure to find nests may well be masking abundance, perhaps superabundance, of migratory females, that in other circumstances would not have the opportunity to nest in seemingly barren pools.

Acknowledgments.

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Walter E. Meshaka Jr.[1]*, Stephanie I. Williams*[2]*, Sarah R. Bartle*[2]*, Pablo R. Delis*[2]*, and Eugene Wingert*[3]

Section of Zoology and Botany, State Museum of Pennsylvania, 300 North Street, Harrisburg, PA 17120 USA[1]

Department of Biology, Shippensburg University, 1871 Old Main Drive, Shippensburg, PA 17257 USA[2]

Department of Biology, Dickinson College, P.O. Box 1773, Carlisle, PA 17013 USA[3]

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Observations on Litters of Dekay's Brownsnake, *Storeria dekayi* from an Urban Population in Northwest Pennsylvania

Brian S. Gray

Abstract.

Seven litters of Dekay's Brownsnake, *Storeria dekayi* were obtained from an urban population in Erie County, Pennsylvania, USA. Litters occurred from 24 July to 22 August, with litter size ranging from 6 to 20 young. Sex ratios of neonates did not differ significantly from 1:1. Female neonates had slightly longer average snout-vent lengths (mean 81.3 mm) compared to males (mean 77.6 mm). However, there was no significant difference in average total length (TL) between sexes. Relative tail length (tl/TL) in male neonates (0.245) was greater than that of females (0.214). Average mass (0.38 g) was similar between male and female neonates. Relative clutch mass (RCM) of six litters averaged 0.382.

Introduction.

Dekay's Brownsnake, *Storeria dekayi* (Figure 1) is a small viviparous natricine snake common throughout much of eastern North America. The ability of this species to persist in urban habitats is well-known (Klemens 1993; Hulse et al. 2001; Willson and Dorcas 2004). Published reproductive data from urban populations in northwest Pennsylvania is sparse, and primarily consist of dates of parturition and litter sizes (Gray and Lethaby 2008; Gray *in press* a). Researchers have noted that a lack of basic life-history data, including detailed information regarding a species' reproductive biology, can limit the ability to develop effective conservation and management strategies (Ernst 2003; Dorcas and Willson 2009; Shine and Bonnet 2009; Meshaka 2010). Conversely, an understanding of a species' reproductive biology can provide a robust basis for developing effective management strategies, and is essential in assessing population viability (Shine and Bonnet 2009).

Figure 1. A gravid female Dekay's Brownsnake, *Storeria dekayi* from Erie County, Pennsylvania.

Herein I provide data on litter size, sex ratios, morphometrics, and relative clutch mass of Dekay's Brownsnake, *S. dekayi* from northwest Pennsylvania, USA. The data presented here augments our knowledge of the reproductive biology of *S. dekayi* in Pennsylvania.

Materials and Methods.

Between August 1997 and August 2013, seven gravid *S. dekayi* were collected from a site in Erie County, Pennsylvania. The site and natural history of the area's herpetofauna, including *S. dekayi*, has been reported previously (Gray 2007; Gray 2009; Gray *in press* a). Dates of parturition and litter sizes for Erie County *S. dekayi* were given in Gray and Lethaby (2008).

Individual female *S. dekayi* were housed in plastic ventilated containers (32.7 x 18.7 x 10.8 cm) with shredded paper as a substrate. Water was available to the snakes at all times. Snakes were checked twice daily, once in the morning and once in the evening. As soon as neonates were observed, the female was monitored until it was determined that she had given birth to all her young. Within 24 h of birth, snout-vent length (SVL) and tail length (tL) of postpartum females and neonates were measured to the nearest mm with a clear plastic ruler. Female postpartum mass was obtained with a digital scale or a spring scale, both to the nearest 0.1 g. Mass of neonates from three litters was measured with a digital scale accurate to 0.01 g. For three additional litters, the average weight of neonates was obtained by weighing all young to the nearest 0.1 g with a digital scale, then dividing by the total number of young. For all gravid females, the date of capture to parturition was < 45 days. Females and their litters were released at the initial capture site of each female. In this paper relative clutch mass (RCM) = total mass of litter/female postpartum mass + total mass of litter (Seigel et al. 1986).

Summary statistics, mean ± 95% confidence interval, range, and sample size are provided. I used *t*-tests (two-tailed) for comparing means when sample sizes were less than 30; *z*-tests (two tailed) were used for comparing means when sample sizes were 30 or more. Prior to performing *t*-tests, an *F*-test was used to determine whether variances were homogenous. In the event variances were heterogeneous, a *t*-test assuming unequal variances was employed. Chi-square tests employing Yate's correction for continuity were used to determine if sex ratios departed significantly from a 1:1 ratio (Fowler et al. 1998). The relationship between female SVL and litter size was analyzed using the Spearman Rank Correlation Coefficient (r_S). With the exception of Chi-square tests and the Spearman Correlation Coefficient, which were calculated with pencil, paper, and calculator, I used Microsoft Excel 2010 for data analysis. Alpha for all tests was 0.05.

Results.

Dates for litters were 24 July, 6 August, 8 August, 13 August, 16 August, 20 August and 22 August. Litter size ranged from 6 to 20. Sex ratios of male to female neonates ranged from 1.0:0.5 to 1.0:2.4. Three litters were male-biased, two were female-biased, and one contained equal numbers of males and females. Of six litters for which data were available, none differed significantly from 1:1 (Table 1). Stillborn young were present in two litters. The first, a litter of 20 young contained 2 stillborn males. The second, a litter of 19 young contained 8 (3 males and 5 females) stillborn snakes. One of the stillborn snakes from this litter was very small (40 mm TL) and deformed. Scales were lacking from portions of the dorsal surface, and ventral scales were present, but divided. There were four kinks in the body, and the tail was coiled. Another neonate from this litter, born alive, was similar to the deformed specimen, in that it had scoliosis.

There was a significant difference in SVL (z = -3.18, P = 0.001) between male (mean 77.6 ± 1.9 mm, range 63.0 – 89.0, n = 39) and female (mean 81.3 ± 1.4 mm, range 70.0 – 88.0, n

Table 1. Sex ratios of litters of Dekay's Brownsnake, *Storeria dekayi*.

Litter	Male	Female	X^2	*P*
13-Aug-03	5	5	0.1	>0.05
16-Aug-03	5	12	2.12	>0.05
8-Aug-08	4	2	0.17	>0.05
24-Jul-12	11	9	0.05	>0.05
6-Aug-13	6	9	0.27	>0.05
22-Aug-13*	12	6	1.39	>0.05

*Litter size was 19; however, it was not possible to determine the sex of a stillborn individual that was malformed.

= 41) neonates, with females averaging larger in SVL. There was no significant difference in TL (z = -0.56, P = 0.573) between male (mean 102.8 ± 2.3 mm, range 85.0 – 115.0, n = 39) and female (mean 103.6 ± 1.6 mm, range 90.0 – 111.0, n = 41) neonates. There was a significant difference in tL/TL (z = 8.83, P < 0.001) between male (mean 0.245 ± 0.005, range 0.190 – 0.270, n = 39) and female (mean 0.214 ±0.004, range 0.190 – 0.240, n = 41) neonates, with males having relatively longer tails. There was no significant difference in mass (t = -0.322, df = 51, P = 0.749) between male (mean 0.38 ± 0.02 g, range 0.30 – 0.45, n = 29) and female (mean 0.38 ± 0.02 g, range 0.31 – 0.45, n = 24) neonates.

Relative clutch mass of six litters ranged from 0.222 to 0.441 (Table 2). There was a modest correlation (r_s = 0.49) between female SVL and litter size (Figure 2), however, the relationship was not statistically significant (P > 0.10).

For three gravid females, prepartum mass was obtained 4- 36 days prior to parturition. Differences between female prepartum mass and female postpartum mass + litter mass was 3.0, 3.1, and 3.35 g, respectively. Such differences are due to water loss and mass of natal membranes.

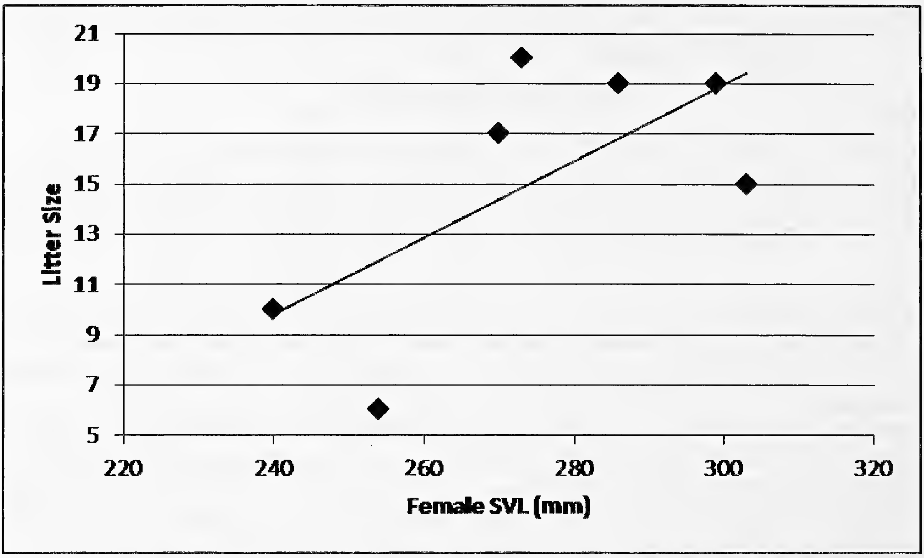
Discussion.

Reproduction is triggered in part by environmental cues, such as temperature, rainfall, or photoperiod (Vitt and Caldwell 2009). Thus, timing of reproduction may vary between seasons;

Table 2. Reproductive data for six litters of Dekay's Brownsnake, *Storeria dekayi* from northwestern Pennsylvania.

Date	Clutch Mass (g)	Litter Size	Female Mass (g)	RCM
5-Jul-03	5	10	12	0.417
16-Aug-03	7	17	18.25	0.384
8-Aug-08	2	6	9	0.222
24-Jul-12	6.5	20	14.75	0.441
6-Aug-13	6.1	15	14.4	0.424
22-Aug-13	7.4	19	18.4	0.402

Figure 2. Relationship between female *Storeria dekayi* SVL and litter size.



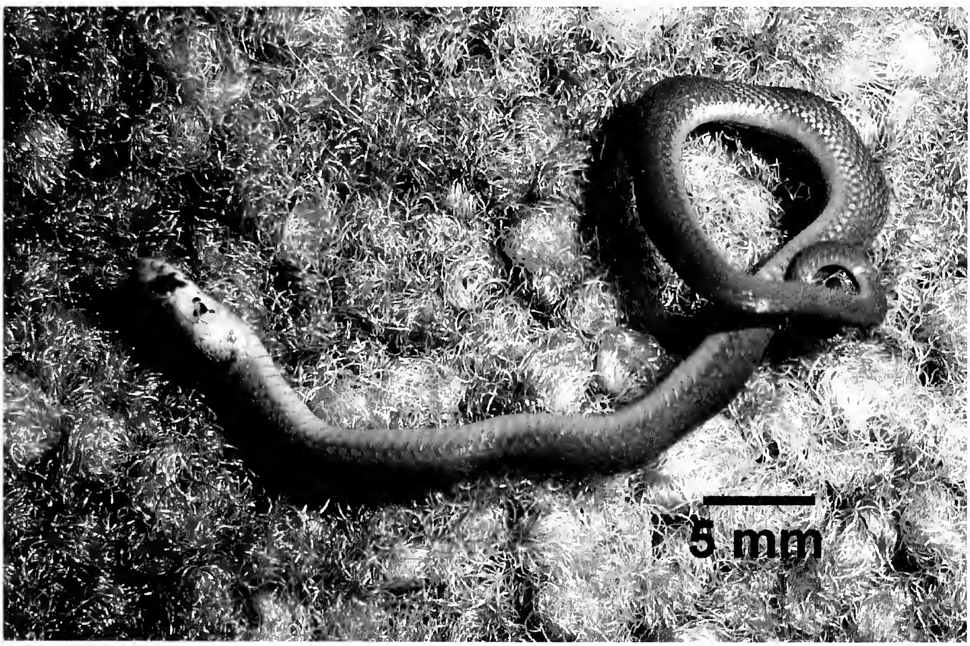
an early spring coupled with above average temperatures during summer may allow for more rapid development of embryos and earlier parturition. Hulse et al. (2001) noted that in Pennsylvania *S. dekayi* parturition can occur as early as 11 July, although most females gave birth in the first half of August. Short-term captive females from southeast Pennsylvania gave birth to young between 20 August and 15 September (Ernst 2003). Birth dates for nine *S. dekayi* litters from Virginia were between 22 July and 30 August (Mitchell 1994). Dates of parturition in my study were similar to Hulse et al. (2001), with most (N = 6) occurring between 6 August and 22 August. The earliest litter (22 July 2012) occurred during a drought year with below average rainfall and above average temperatures (Gray *in press* a). The relatively early parturition dates of *S. dekayi* are possible, in part, to this species cold tolerance with early emergence from hibernation, along with a short gestation period (Fitch 1999). In Erie, Pennsylvania *S. dekayi* is one of the earliest snakes to emerge from hibernation (Gray 2011) and is able to survive brief periods of subfreezing temperatures (Gray *in press* b). Parturition occurs earlier in southern populations (Kofron 1979; Palmer and Braswell 1995), and in Florida may occur in spring (Ashton and Ashton 1981; Meshaka 1994). Earlier parturition in southern populations is due in part to higher annual average temperatures and a longer activity season. A female (330 mm TL) collected from my site on 21 August 1994, and maintained in captivity produced a litter of young on 26 January 1995. Thus, fall mating and/or sperm storage occurs at the Erie County site.

Litter size may vary geographically, with some species having an increase in litter size from south to north. Fitch (1985) observed that in northern populations, where growing season is short, increased female body size may be part of a strategy for increased reproductive output. Throughout the geographic range of *S. dekayi* litter size varies from 3 to 41 neonates (Fitch 1970; Morris 1974). Average number of young in 169 litters of *S. dekayi* reported in the literature was 13 (Ernst and Ernst 2003). Litter size in Pennsylvania varies from 5 to 25 young (Hulse et al. 2001). In southeast Pennsylvania Ernst (2003) observed 6 to 19 young per litter. The average litter size of 42 litters from Kansas was 12, and ranged from 4 to 24 (Fitch 2003). Litter size in North Carolina ranged from 4 to 26 and averaged 13 (Palmer and Braswell 1995). Litter sizes observed by me were similar to those noted above.

Sex ratios of *S. dekayi* neonates reportedly are female-biased (Ernst and Ernst 2003). In Virginia, Mitchell (1976) noted a male to female ratio of 1.0:1.3. In a combined sample of 14 litters from Long Island, New York, Clausen (1936) obtained a male to female ratio of 1.0:1.2. In my study, sex ratios of neonate *S. dekayi* from 6 litters varied from 1.0:0.5 to 1.0:2.4. Sex ratio of adult *S. dekayi* from my study site are male-biased (Gray *in press* a), suggesting a higher mortality of females. Skewed sex ratios can be characteristic of species with temperature dependent sex determination (TSD); however, there is no evidence for TSD occurring in *S. dekayi*.

Stillborn young (1-4) occurred in 6 of 14 (43%) litters studied by Clausen (1936). Morris (1974) noted a single stillborn individual in a litter of 41 young from Illinois. Holman (2012) had a Michigan female *S. dekayi* that gave birth to 11 young, 7 of which were stillborn. Stillborn young may represent 2.4% to 63.6% of a litter (Morris 1974; Holman 2012). Of 194 neonates from numerous litters, Ernst (2003) only observed four stillborn young. In my study, stillborn individuals (2 and 8) in two litters represented 10% and 42% of each litter, respectively. The latter litter was born on 22 August 2013. Two of the eight stillborn young had scoliosis. A live male also had scoliosis. The spine in this individual was kinked in seven places and the tail was curled (Figure 3). The individual

Figure 3. *Storeria dekayi* with scoliosis born 22 August 2013. Total litter size was 19, and contained 8 stillborn young.



was able to move, although forward progress was extremely difficult. The merolepid specimen was similar to stillborn merolepid *Thamnophis sirtalis* (Gray et al. 2003).

The observation in this study, of female neonates being on average larger (SVL) than males has previously been reported. Mitchell (1976) observed a litter from Virginia with males (N = 6) averaging 61.7 mm SVL and females (N = 8) averaging 64.3 mm SVL. Most morphometric data for neonate *S. dekayi* are combined samples of males and females. Hulse et al. (2001) reported a mean SVL of 74.5 mm and a mean TL of 96.8 mm for Pennsylvania *S. dekayi* neonates. The aver-

age SVL of 194 neonates from southeastern Pennsylvania was 74 mm (Ernst 2003). Neonates from Long Island, New York averaged 93.2 mm TL (Clausen 1936). Virginia neonates (N = 47) averaged 68.9 mm SVL and 91.3 mm TL (Mitchell 1994). Average SVL (79.4 mm) of eighty neonates in my study was slightly higher, but similar, to average SVLs reported for Pennsylvania *S. dekayi* (Hulse et al. 2001; Ernst 2003). Average TL (103.2 mm) of neonates (N = 80) in my study was slightly greater than reported by Clausen (1936), Mitchell (1994) or Hulse et al. (2001). In North Carolina, relative tail length in male neonates averages 0.253 (range 0.231-0.279, N = 35), while in female neonates it averages 0.219 (range 0.205-0.239, N = 33) (Palmer and Braswell 1995). The greater relative tail length of male neonates compared to females is expected. In adult *S. dekayi* males have relatively longer tails than do females (King 1997; Hulse et al. 2001; Gray *in press* a). Mitchell (1994) obtained an average mass of 0.28 g for neonates from Virginia. Mass of neonates from North Carolina (N = 93) and southeastern Pennsylvania (N=194) both averaged 0.25 g (Palmer and Braswell 1995; Ernst 2003). Average mass of neonates (0.38 g) in my study was slightly higher than the values cited above.

Relative clutch mass may represent a trade-off between the benefits of a high investment in reproduction and the cost of that investment, especially with respect to foraging and escape behavior (Pough et al. 2001). For example, retaining developing embryos until parturition may burden a gravid female, making her more vulnerable to predation and shortening her life expectancy (Fitch 1985). In some lizards, as RCM increases, females became slower, suggesting that survival costs increase proportionately with reproductive effort (Vitt and Caldwell 2009). However, in the Australian skink, *Lampropholis guichentoni*, decreased body temperature, ingesting of large prey, and tail loss had nearly twice the effect that pregnancy had (Vitt and Caldwell 2009). Relative clutch mass of *S. dekayi* has been reported to range from 0.32-0.48 (Seigel et al. 1986; Meshaka 1994; Ernst 2003). Average RCM for my study was similar and averaged 0.382. The lowest RCM of 0.222 was obtained by a 254 mm SVL female that had a litter of only 6 young. RCM of a given species may be determined by a suite of life history correlates such as reproductive mode, escape behavior, and foraging strategy (Seigel et al. 1986). In viviparous species RCM tends to decrease with increasing body size (Seigel et al. 1986). Because of the small sample size (N = 6) it was not possible to determine if a statistically significant trend occurred in my population. However, RCM of the 3 smallest females (240-270 mm SVL) ranged from 0.222 to 0.417, while RCM of the three largest females (273-303 mm SVL) ranged from 0.402-0.441 (Figure 4).

An increase in available resources may result in increases in clutch mass and the number of offspring. Fitch (1985) noted a weak northward increase in litter size of *S. dekayi*. In *S. dekayi*, the largest females tend to produce the largest litters (Klemens 1993; Fitch 1999; Hulse et al. 2001; Ernst 2003). Fitch (1999) noted that primiparous females produced relatively small litters compared to larger and older females. Similarly, female *S. dekayi* in my study greater than 260 mm SVL produced litters that had nearly twice the number of young than those of smaller females. Although the correlation between female SVL and litter size was not statistically significant, the two largest litters (19 and 20 young) in my study were produced by the second (299 mm SVL) and third (273 mm SVL) largest females. Due to limited data from six litters, I did not test the relationship between litter size and average size of neonates. However, a plotting of the data implies that a reduction in average TL occurs as litter size increases (Figure 5).

In addition to augmenting our knowledge of *S. dekayi* from urbanized northwest Pennsylvania, reproductive data as presented here is important in assessing the viability of populations and developing species management plans. *Storeria dekayi* has the potential of establishing populations outside its current natural distribution. For instance, *S. dekayi* has been introduced into the Bahamas (Lee 2005), and it is not known what impacts, if any, this may have on the native gastropods or earthworms there. Therefore, the above data may also be of use in developing an action-plan to limit the spread of alien populations of *S. dekayi*.

Figure 4. Postpartum female *Storeria dekayi* (303 mm SVL) with litter of 15 young. Relative clutch mass was 0.424.

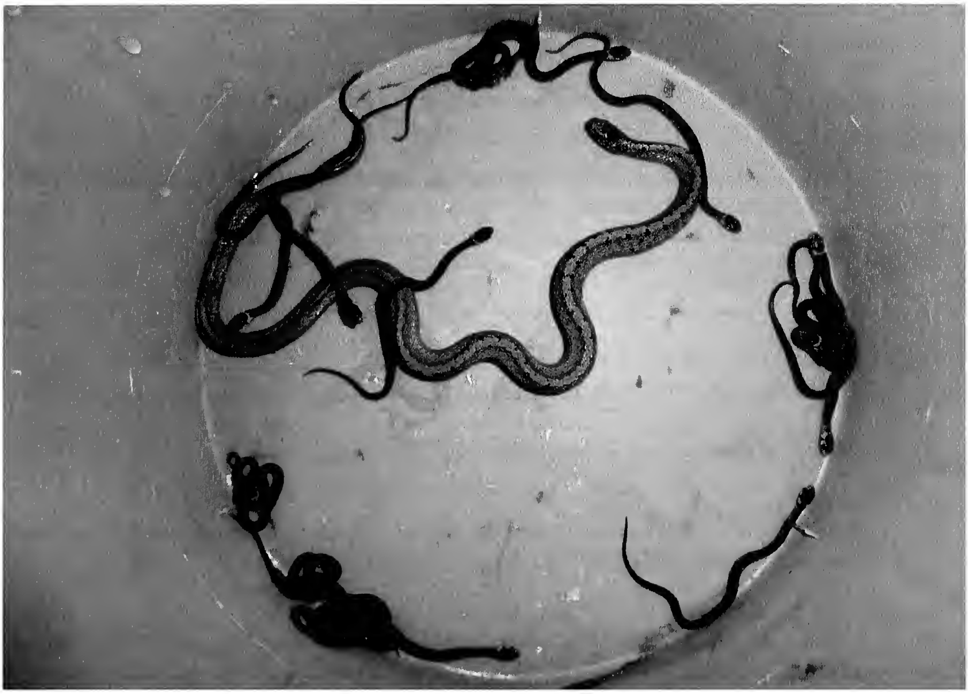
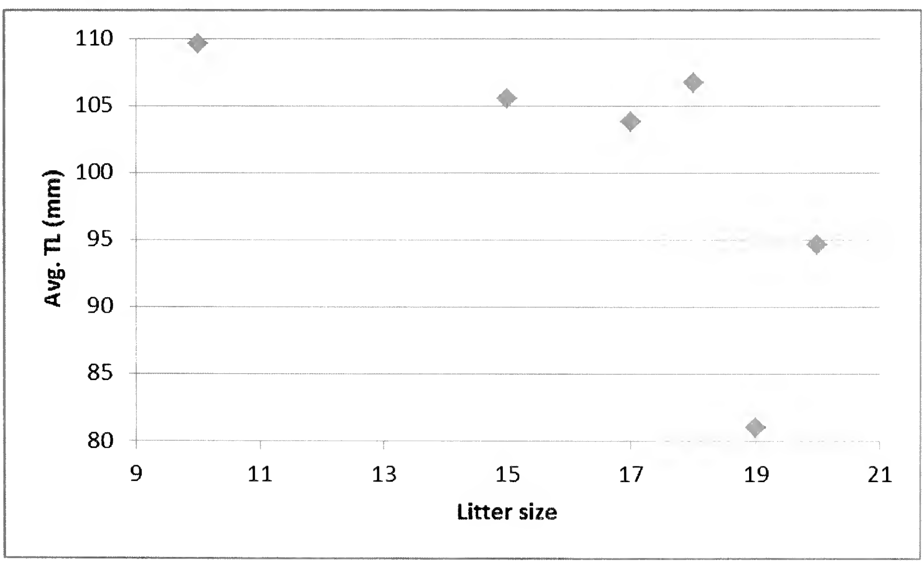


Figure 5. At the Erie County, Pennsylvania site, as the number of neonates in a litter increases, the average TL of the neonates tends to decrease.



Acknowledgments.

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Brian S. Gray, Natural History Museum at the Tom Ridge Environmental Center, 301, Peninsula Drive, Erie, Pennsylvania 16505. brachystoma@hotmail.com

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The Distribution of the Northern Scarlet Snake, *Cemophora coccinea copei* (Jan, 1863), in Maryland and Delaware with a review of the known records

It has taken almost 151 years, for the distribution of the Northern Scarlet Snake, *Cemophora coccinea copei* (Jan, 1863) in Maryland, to be understood. The earliest record for *C. c. copei* in Maryland is based on a specimen the collection of the Museum of Comparative Zoology (No. 750) at Harvard, collected in 1862, by Prof. A Wyatt in Baltimore (Fowler, 1945). Stejneger (1905) reported that early in 1891 a live specimen was sent to the museum from St. Margarets, Anne Arundel County, Maryland by A. A. Stinchcomb but unfortunately escaped. A drawing and a color description of the living specimen confirmed the identification. Cope (1900), mentions this specimen. Stejneger (loc. cit.) also reported a specimen from the vicinity of Anacostia, District of Columbia (USNM 35308) collected in 1893 by an employee of the St. Elizabeth Hospital. Fowler (loc. cit.) reports specimens from Salisbury (AMNH 77104), Wicomico County, Maryland (541 mm) collected by J. P. Brown, April 5, 1923 [(Littleford,1955)(Conant, 1958)] and from Brandywine, Prince George's County, Maryland on the basis of a photograph in the possession of C. S. East, and mentions the St. Margarets record as well as the Severn, Anne Arundel Co., Maryland and St. Denis, Baltimore Co., Maryland records reported by Kelly, Davis and Robertson (1936). He restricts *Cemophora* to the Coastal Plain.

Kelly, Davis and Robertson (loc. cit.) report that only three specimens are known from Maryland. They mention the St. Margarets specimen mentioned above and report on two others not represented by specimens. One from near Severn, Anne Arundel County, Maryland and one from near St. Denis, Baltimore County, Maryland, close to the Patapsco River, under an old log in August, 1929 (14 inches). Subsequent authors McCauley (1945), Cooper (1950), and Harris 1969, 1975) did not accept these records for reasons including no specimens, and based on a number of errors on species inclusions in their book, and in the case of the St. Denis record assumed the species was only a Coastal Plain form. Although there are no specimens, I now do accept these records as valid. Severn is well within the range of *Cemophora coccinea copei* and St. Denis for reasons to be pointed out later.

McCauley (loc. cit.) lists the known specimens mentioned above, save for the Baltimore record, and gives reasons for not accepting the "near St. Denis and "near Severn" records. He states they could have been misidentified as the specimens were not seen by a qualified herpetologist. He also states in the case of the St. Denis record that *Cemophora* is restricted to the Coastal Plain. McCauley also mentions a specimen from Lanham, Prince George's Co., Maryland (J. A. Fowler). This must have been a personal communication received late as he mentions the specimen locality is not on his map.

Cooper (loc. cit.) points out that between "1862 and 1948, there have been only nine "authentic" (quotes mine) records for the scarlet snake, *Cemophora coccinea* (Blumenbach) from Maryland and the District of Columbia". He points out that the specimens reported by Kelly, Davis and Robertson (loc. cit.) are questionable for the reasons given by McCauley (loc. cit.). Concerning the Baltimore record, he states that since this area is predominately Piedmont, the scarlet snake's occurrence seems highly improbable. He stated that "Probably, the specimen in question was collected in or near the South Baltimore Suburbs since this locality is near the Coastal Plain region of the state, where the species would be expected". In 1862, the city of Baltimore was basically the area we now call the Inner Harbor, which is the southern portion of what we call Baltimore today. He then proceeds to add three more Maryland specimens to the list bringing the total to his

nine. One from Calvert County, at Cove Point, he found DOR (ca. 18 inches) July 7, 1946, while the other two were from Anne Arundel County. The first (NHSM-R716) was found DOR, August 3, 1946, about 0.5 mi NE Priest Bridge on US RT. 301, by J. E. Cooper and M. F. Groves and the second (USNM 141395) collected June 8, 1947 at Mill Creek near Arnold by Philip A. Butler. More specific, " smaller Mill Creek, tributary of Patuxent River at Hills Bridge". Including the specimens from Severn and St. Denis it would bring the total known Maryland records to eleven.

Harris (1969, 1975) mentions that the Scarlet Snake, *Cemophora coccinea copei*, is restricted to the Coastal Plain in Maryland. He mentions two sight records, reported as valid by Doris M. Cochran, for St. Michaels and Tilghman Island, Talbot County, Maryland, collected by kids. He also mentions a specimen that was donated to the Chesapeake Biological Laboratory and given to him for the Natural History Society of Maryland collection by J. D. Hardy, Jr. This specimen, a juvenile, 153 mm, was found by a resident of Olivet, Calvert County, Maryland, in a basement window well on September 14, 1977. Miller (1980) lists the specimen in a note on distributional records for Maryland. This brings the total Maryland specimens to fourteen.

Grogan (1985, 1994) reported two specimens from Worcester County, Maryland, a large specimen 530 mm, was collected by Mark Mengele in Shad Landing State Park, during June 1975, and another large individual (ca. 450 mm) found by Michael Geiger under sheet metal at Millville off old Stagecoach Road, N of MD Rt. 12, on May 25, 1991. Grogan (2008) reports two additional specimens, found DOR, from near the latter locality, Millville Road, 2.5 km SW junction with MD Rt. 12. The first found by Grogan and Matthew T. Close on 12 June 2004 (ANSP 36238), and the second found by L. T Biechele on July 26, 2005 (deposited in the Vertebrate Collection at Salisbury State University). Loblolly Pine *(Pinus teada)* is prevalent on Maryland's lower Delmarva. "The 2 DOR *Cemophora* were found in a small cut-over section of a Loblolly farm. In this area just E of and scattered throughout the Furnace preserve are also Shortleaf *(Pinus echinata)* and Virginia *(P. virginiana)* pines plus a few Pond pines *(P. serotina)* in lower, wetter areas such as along Sand & Forest roads. This area features the highest dunes in Worcester Co. (ca. 65') and the largest remnant Shortleaf pine forest with some trees over 120 years old. Botanists now regard Shorleaf pine as the historically dominant pine on the higher coastal plain dunes, but they're much slower growing than Loblolly pine*(Pinus taeda)*, which typically occurred along stream margins"(William Grogan). "The 2 DORs on Melville Road were associated with Loblolly Pine (Pinus taeda) plantations, though there were also naturally occurring loblollies. The snakes could have also come out of the bottomland forest of the Nassawango Creek floodplain which would have been much more diverse and dominated by native hardwoods, though the high dry sandy rise where they were killed was loblolly. The two Dorchester County reports were also from sandy areas dominated by loblolly, though there was more diversity of mixed hardwoods, too" (Scott A. Smith). The total number of reported Maryland records now stands at eighteen.

Reed (1956) lists a *Cemophora coccinea* (USNM 138858) from Scientist Cliffs, Chesapeake Beach, Calvert Co. Maryland, collected by Glynn H. Frank in July, 1956. Examination of the USNM catalogue, shows this record as modified January 2003 and the specimen as *Lampropeltis triangulum* (*ssp. temporalis* per HSH). Obiviously it had been misidentified as *Cemophora* (J. Jacobs, R. G. Tuck, Jr.).

While examining the USNM holdings of *Cemophora*, I discovered a previously unreported specimen from Maryland. USNM 307452 is listed as having been collected May 1, 1949 in Charles Co., Maryland, by J. R. Linter, Jr. It was reportedly found at the edge of a wheat field adjacent marsh along creek, tidal Section of Nanjemoy Creek, Charles Co., Maryland and represents a new county record for *Cemophora* in Maryland. The number of reported Maryland records is now nineteen.

White and White (2002) state only four records exist for Delmarva and all in the Coastal Plain. They mention the Salisbury, Wicomico Co., Maryland record (Fowler, loc. cit.) and the two specimens from Worcester Co. Maryland (Grogan 1985, 1994) and one from Delaware, at Buzzards Point, southern shore of Trap Pond, Trap Pond State Park, Sussex County, Delaware, found on June 21, 1963 (Arndt, 1985). As of this note, this is the only specimen known from Delaware (J. F. White, Jr.).

On May, 28, 2013, Kevin Crocetti, collected a specimen of the Scarlet Snake, *Cemophora coccinea copei* (Fig. 1), in Rockburn Park, Howard Co., Maryland. It was found under a log after a heavy thunder storm. It was found in a coniferous stand, with well drained sandy soil adjacent to a deciduous wooded area (Fig. 2A, 2B). The pine found here is the Pitch Pine, *Pinus rigida*, and is known for its preference of sterile soils. This area is in the Piedmont at 67 meters. Howard County also represents a new county record for *Cemophora* in Maryland. The St. Denis area, also in the Piedmont, but up a "river valley" is about 2 mi ESE of the Rockburn record.. These records firmly establish that this snake inhabits the Piedmont in Maryland, and removes any concern of exactly where in Baltimore the "Baltimore" specimen was collected. *Cemophora coccinea copei* is found in the Piedmont in other states but appears to be most abundant in the Coastal Plain. The following statement outlines their distribution in both the Coastal Plain and in the Piedmont. " Scarlet snakes are found throughout Coastal Plain and Piedmont regions of the southeastern U.S., from the Pine Barrens of New Jersey west to Oklahoma and throughout Florida. Within this region, however, they are generally most common in the Coastal Plain and Sandhills and are uncommon and scattered in distribution within the Piedmont" (Wilson, 1998). Figure 3 shows the current known distribution of *Cemophora coccinea copei* in Maryland and Delaware.

Figure 1. *Cemophora coccinea copei* from Rockburn Park, Howard Co., Maryland.

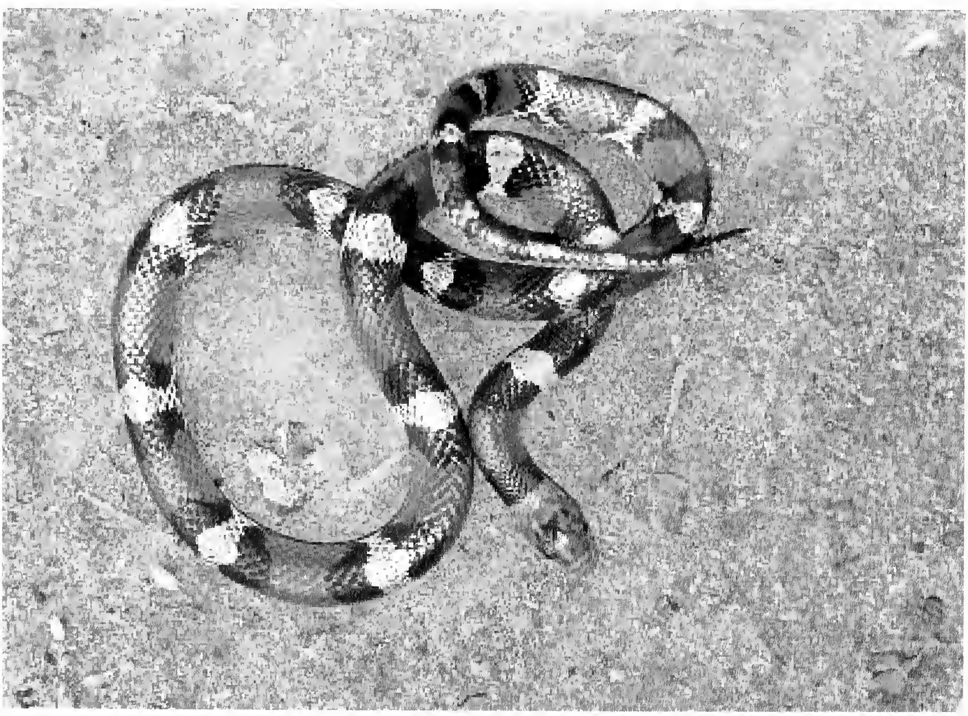


Figure 2A. The Howard County specimen is shown in front of the log from under which it was captured. The pine needles and debris were brushed aside to show the loose sandy substrate.

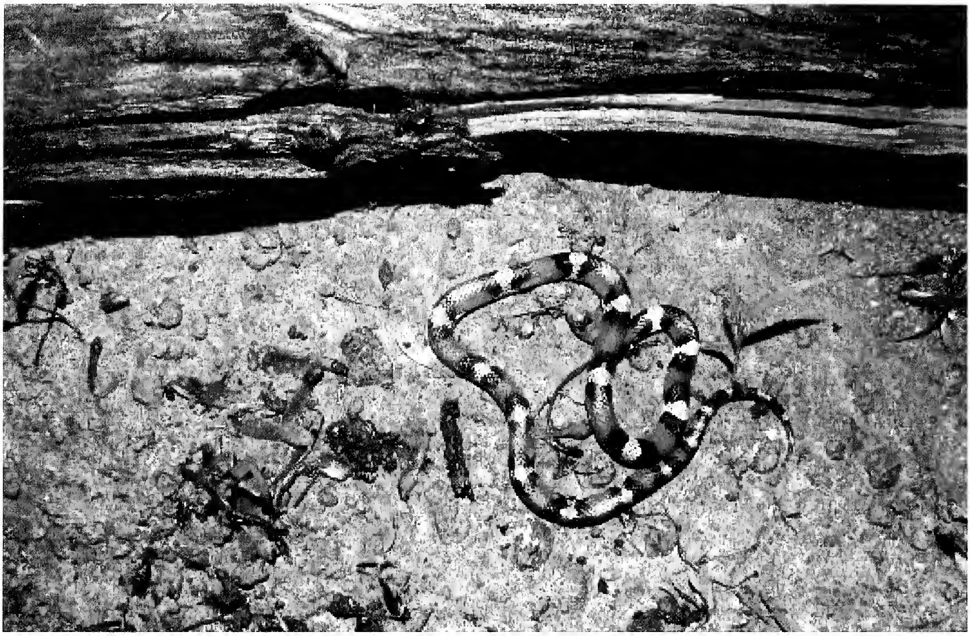
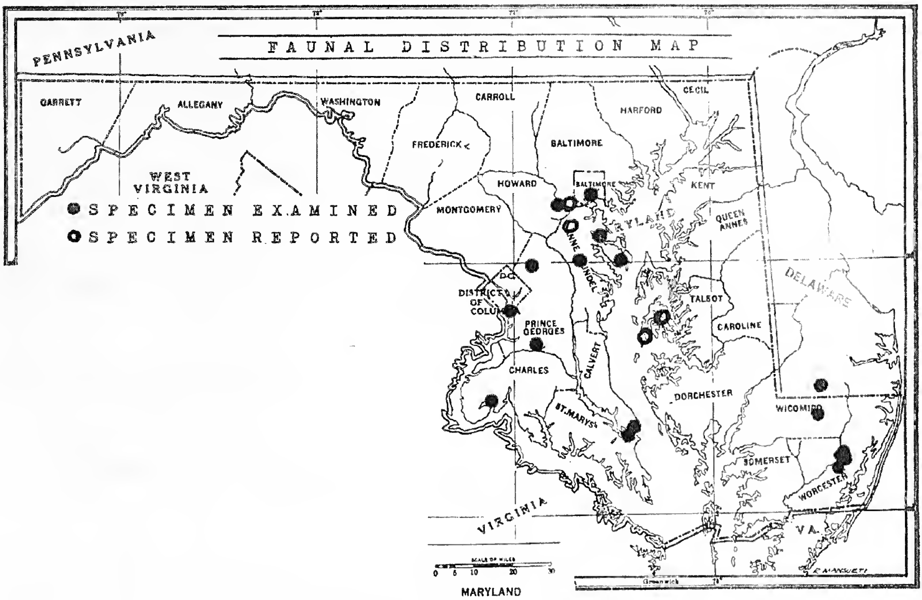


Figure 2B. A general photograph of the habitat showing the coniferous stand adjacent to the deciduous wooded area.

Figure 3. Map showing the distribution of *Cemophora coccinea copei*, in Maryland and Delaware.



Scott A. Smith informs me of the following: "There was a potential DOR in Dorchester County about 8-12 years ago off of Harrison Ferry Road just west of the Marshyhope River, but unfortunately the DNR employee (a mammalogist) who reported it did not check the belly so we don't know if it was a coastal plain milk or scarlet. I hesitate even mentioning it. In the same vein, there was also a verbal report for Dorchester County from about 15-20 years ago of a scarlet dug up at Tudor Farms, which is a private game preserve north of Bestpitch and south of Decoursey Bridge Road (west of Hurlock Creek), but with no photo or specimen it is hard to accept." I think of *Cemophora coccinea* as being fossorial whereas *Lampropeltis triangulum temporalis* as secretive, however, in loose sandy soil, consistent burrowing is certainly not out of the question. These records are interesting but as Scott mentions cannot be accepted without a proper identification.

I would like to thank Jerry D. Hardy, Kevin Crocetti, William Grogan, Jr., Jeremy Jacobs, Scott A. Smith, Robert G. Tuck, Jr. and James F White, Jr., for material pertinent to this note. Photographs by Kevin Crocetti.

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Herbert S. Harris, Jr., Department of Herpetology, Natural History Society of Maryland, Inc., P.O. Box 18750, 6908 Belair Road, Baltimore, Maryland 21206. (hsharris@juno.com)

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Cannibalism in the Green Frog, *Lithobates clamitans melanotus*, in Maryland

Over the years, I have only seen cannibalism in captive adult amphibians, except for tadpoles and larval salamanders. I have always assumed it occurred but never witnessed it. While driving roads, and examining carcasses, on 13 September 2013, I came across a large DOR Green Frog, *Lithobates clamitans melanotus*, which was badly mutilated. On close examination, I noticed a young specimen of *Lithobates clamitans melanotus* in its stomach area. This specimen was intact and must have been recently swallowed as digestion had not started. This was 0.3 mi E Severn Run, on Dicus Mill Road, Anne Arundel Co., Maryland.

Cannibalism has been observed in the Green Frog, *Rana perezi* by Kemer (2012), and in the Bull Frog, *Lithobates catesbeianus* (2010 Roach). Tyler (2004) wrote a book for kids on cannibalism in frogs.

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Herbert S. Harris, Jr., Department of Herpetology, Natural History Society of Maryland, Inc., P.O. Box 18750, 6908 Belair Road, Baltimore, Maryland 21206. (hsharris@juno.com)

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Toilet Frogs... They're Back!

Harris (2008) reported on a series of observations of specimens representing the *Hyla chrysoscelis/versicolor* complex observed sitting on the toilet bowl at his home, in Severn, Maryland. After lifting the toilet seat, the frog would be seen sitting on the porcelain rim of the toilet bowl. Since 2008 they have not been seen until this year, 2013. This year has been much drier than seen in 2008. The wood lot adjacent to my house has been gone for two years now, replaced by at least seven houses. There is a small patch of trees remaining, several hundred feet away.

At 7:00 am, on 4 September 2013, two specimens were observed side by side on the rim, with their heads peering out from under the toilet seat. Snout vent length was 32 and 33 mm respectively. There is a shower next to the toilet and I removed the perforated metal cover over the drain and continued to watch for more frogs. The drain's trap was not full of water.

At 7:00 am, on 9 September 2013, an additional treefrog was observed on the rim. Snout vent length was 35 mm. These frogs were somewhat smaller then those observed in previous years. None were seen in the shower.

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Herbert S. Harris, Jr., Department of Herpetology, Natural History Society of Maryland, Inc., P.O. Box 18750, 6908 Belair Road, Baltimore, Maryland 21206. (hsharris@juno.com)

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The Maryland Herpetological Society
The Natural History Society of Maryland
P.O. Box 18750
6908 Belair Road
Baltimore, MD 21206

Natural History Society of Maryland

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